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By Mr. CHARLES LEADBETTER.

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NEW ART



OF THE ARTS, AND THE HISTORY OF
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P R E F A C E.

SEEING the Business of Dialling, if Mechanically considered, is of itself a Thing so natural and easy, one would wonder, after so much learned Bustle as the Mathematicians have made about it, that they should have more perplexed and obscured than promoted the Knowledge of that useful and entertaining Art amongst the Generality of Mankind.

The different Ways, in which these Gentlemen have hitherto chose the World should see that useful Subject handled, would certainly have been right and proper, and liable to no Exception, if all Men were Mathematicians: But how few are such? And therefore their having treated of Dialling in a Geometrical, Instrumental or Arithmetical Method, I am sure cannot possibly be of any Use or Signification to such as know nothing at all of those Sciences, or the Doctrine of the Sphere.

Certainly, there are two very different Ends of writing Books, which treat of any Art or Science; the one is to advance the Art or Science itself, and the other to instruct Learners.

Now, with respect to the Former, the Extent and Capaciousness of the Subject is chiefly to be regarded; and nothing is to be omitted which properly falls within the Compass of the Art or Science treated of; but with respect to the latter, the Capacities of the Learners are principally to be considered, and Notice is to be taken, not of whatever may be known or done by the Art or Science treated

of, but only of what is most useful, and withal most easy to be known.

The most proper and rational Method, therefore, to make any one Master of any Art or Science, is to introduce it to him after the most plain, familiar and natural Method, and to teach him at first only so much of the Art as is really useful in common Life, and withal most easy to be understood; and when he has gone through, and is become Master of what is most useful and easy, he will be enabled with more Ease to conquer the more difficult Parts of it, and to pursue the Study of it after a more learned Manner, if his own Inclinations or Profession shall incline him so to do.

Upon these Considerations, and with this View it was that I drew up this Treatise of Mechanick Dialling, because of all those who have hitherto treated upon this Subject in the English Tongue for the Instruction of Learners, not one of them seems to me to have thoroughly considered what I have now premised.

By the Method I have observed in this Treatise, the Length and Dryness of the Study of Dialling (which has discouraged many) is quite removed; and it is now rendered not only very useful, but perfectly easy and entertaining: And I think without Vanity I may venture to affirm, that by the Help of this Book only, the Learner may obtain a competent Knowledge in Dialling, in much less Time, and with much less Trouble, than he can by the Assistance of any other, or indeed all the Treatises which have yet appeared in English upon this Subject: where he will either find the easy and useful, and the difficult and useless Elements of this Art promiscuously and injudiciously exhibited and

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and taught together; or else the Subject treated of after such a Manner as can never be comprehended by any one that does not understand some of the abstrusest Branches of the Mathematics.* But

It is high Time that I should now proceed to give the Reader the Particulars of what he may expect to meet with in the following Treatise.

In the first Place, he is made Master of those few Geometrical Problems, which may be of Service to him in Mechanick Dialling.

Secondly, I have taught him not only the Use of the Quadrant and Trigon, but also how to make those universal Instruments, which for their Simplicity, and the great Use they are of in Dialling are never enough to be valued. I have likewise taught him not only the Use of, but also how to make Dialling Scales, and this is not to be met with in any other Treatise extant upon this Subject.

Thirdly, I have given him such plain and ample Directions, that it will be impossible for him to miscarry in making of a Dial for any Place in the World, whether the Dial be Equinoctial, Horizontal, Erect, Declining, Reclining or Inclining.

Fourthly, to these I have added plain and easy Directions for making of Reflective, Refractive and Globe Dials.

I have likewise taught the Reader how to make a Cross Dial, and in this, on account of its Novelty, I have been very full and particular, not only in shewing him after what Manner it must be made, but in having the several necessary Views or Positions of it engraved on Copper. I was tempted to be thus particular, by reason I never yet saw

* Such as Geometry, Astronomy, &c.

or heard that there was any other Dial of that Sort in England, besides that which I have mentioned in this Treatise. And I have also in this new Edition given a Copper-plate of, as well as Directions for making the new invented STAR-DIAL.

Fifthly, I have furnished the Reader with the following very useful and accurate Tables, all adapted to the new Stile.

1. A Table of the Sun's Declination, exactly calculated for the Year 1764, and which (for the Use of Dialling) will serve for this Age without any sensible Error.

2. An exact Table of the Equation of Time for the Regulating of Clocks and Watches by a Sun Dial.

3. A Table for the converting of Hours and Minutes of Time into Degrees and Minutes of the Equinoctial, and *è contra*.

4. A Table for drawing the Hour Lines upon all Horizontal, &c. Dials, from the Equinoctial to the Poles.

5. A Table of the Three Requisites in Dialling, shewing the Substile's Distance from the 12 a-clock Hour Line; the Stile's Height; and the Inclination of Meridians answering to the several Degrees of the Declination of your Plane.

6. A Table shewing the Sun's Altitude for every Hour and Quarter of the Day, at his Entrance into the 12 Signs of the Zodiack.

Sixthly, I have given a plain and familiar Description of the Sphere, for the Sake of such as are inclined to have a true Notion of such Circles in the Heavens, as are frequently mentioned in this and other Books of Dialling.

Seventhly, In Chap. XXIII. is a Collection of
Mottos

Mottos for Dials in Latin and English, suitable to almost all Places where Dials may be fixed.

Eighthly, That nothing may be wanting to render this Work compleat, I have added a new and correct Alphabetical Table of the most eminent Cities, Towns, &c. in the whole World, shewing at each Place the Elevation of the Pole and Difference of their Meridian from London, and this Table may be depended upon to be the best that is extant, because I have spared neither Time nor Pains to correct as many as I could from celestial Observations.

Ninthly, In Chap. XXVI. I have been very full and particular concerning the Manner of making and painting of Dial Planes, and also concerning the preparing the different Colours and Oils proper for that Purpose; and in this I hope to merit the Approbation of those who live in the Country, and cannot upon all Occasions have the Assistance of a professed Painter.

And I have also added Chap. XXVII. concerning Painting Houses, &c. being thoroughly convinced that all those Country Gentlemen, and others, who are inclined to be good Husbands, will think it very well worth their Perusal.

Lastly, Though it may appear a little foreign to my present Purpose, yet for the Entertainment of the curious, I have shewn (in Chap. XXV.) how naturally the two Hands of a Watch or Clock represent the Motions of the Sun and Moon.

And now wishing my Reader as much Benefit from the Perusal of this Treatise, as I have had Pleasure in composing of it, I remain his faithful Friend whilst

CHARLES LEADBETTER.

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N. B. *The DIALS for the following Places are to be found upon the opposite Pages.*

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Chester - - - 21	Ormskirk - - - 54
Constantinople - 91	Oxford - - - 26
Cronton - - - 32	Port Royal - - - 91
Durham - - - 18	Penzance - - - 90
Dublin - - - 59	Shrewsbury - - - 43
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London - 36 & 88	York - - - 24
Norwich - - - 41	

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Mechanick Dialling.

CHAP. I. *Treats of Things necessary to be known by the Mechanick Dial-Maker.*

DIALLING originally is a *mathematical Science*, attained by the philosophical Contemplation of the Motion of *the Sun*, the Motion of *the Shadow*, the Constitution of the *Sphere*, the Situation of *Planes*, and the Consideration of *Lines*.

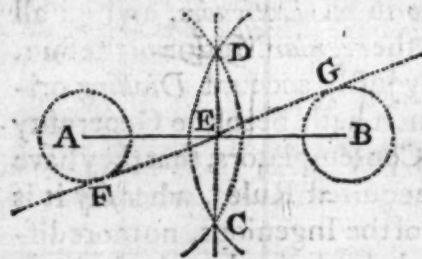
EXPLANATION. The *Motion* of the *Sun* is regular, it moving equal *Space* in equal *Time*; but the *Motion* of the *Shadow* irregular in all Parts of the *Earth*, unless under the two *Poles*, and that more or less, according to the Constitution of the *Sphere*, and Situation of the *Plane*: And therefore *scientific* Dialists, by the geometric Consideration of *Lines*, have found out *Rules* to mark out the *irregular Motion* of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the *regular Motion* of the *Sun*.

But though we may justly account *Dialling* originally a *Science*, yet such hath been the Generosity of many of its studious Contemplators, that they have communicated their acquired *Rules*, whereby it is now become, to many of the Ingenious, no more difficult than an *Art*, and, by many late Authors, so intitled; nay more, by Means of this small *Treatise*, it will scarce be accounted more than a *manual Operation*; for though the Authors I have met with seem to presuppose their Reader to understand *Geometry*, and the *projecting of the Sphere* already, or else endeavour in their Works to make him understand them, as if they were absolute necessary to

be known by every one that would make a Dial, when as in Truth, the contemplative Pains of others aforesaid considered, they are not; but, indeed, are only useful to those that would know the *Reason of Dialling*. Thus they not only discourage young Beginners, but also disappoint many Getlemen and others, that would willingly either make them themselves, or set their Workmen about them, if they knew how to make them. The following Pages I have therefore composd, for the Help of those who understand neither the *Projection of the Sphere*, or *geometrical Operations*.

PROB. I. *To divide a right Line given (as A B) into two equal Parts.*

Open your Compasses to any Extent *more than half the Length* of the Line A B; set one Foot in A, and describe the *Arch* D C, then, with the *same Extent* of the Compasses, set one Foot at B, and



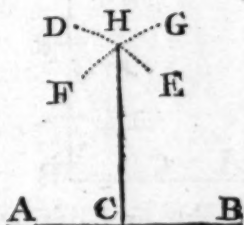
describe the *Arch* D C on the other Side; where these two *Arches cross* each other, lay a Ruler, and draw the *right Line* D C, and it will divide the

right Line *given* in E, the *Middle* thereof. Or the same given right Line may be divided into *two equal Parts*, by setting one Foot of the Compasses on the *End* of the Line at A, and there describe the dotted Circle, and then, with the *same Extent* of the Compasses, draw the *other* dotted Circle at B; lastly, draw the right Line F G, and it will divide the given right Line A B in E, as before. PROB.

PROB. II. To erect or raise a Perpendicular, on the Middle of a given right Line.

N. B. One Line is said to be perpendicular to another, when it cuts it at right Angles, that is, makes a true Square.

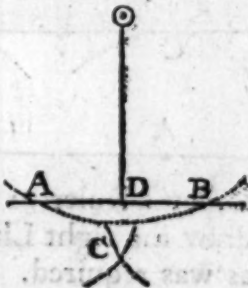
On the End of the given Line at A, set one Foot of the Compasses, and open the other to any Extent, more than half the Length of the Line, and describe the Arch DE; with the same Extent set one Foot of the Compasses at B, and



draw the Arch FG; lay a Ruler to C, the Middle of the given Line, and to the Crossing of the two Arches, and draw CH, which will be perpendicular to AB, as was required.

PROB. III. To let fall a Perpendicular, as $\odot$ D upon a right Line, from a given Point above.

Let the Point above be $\odot$, and the given right Line AB; set one Foot of your Compasses in $\odot$, and extend the other Foot to A, and describe the Arch AB; set one Foot of the Compasses in A, where the Arch cuts the given Line, and draw an Arch at C, with the same Extent; then set one Foot in B, viz. where the Arch cuts the Line, and draw another little Arch at C; lay a Ruler to the given Point $\odot$, and to the Crossing of the two little Arches at C, and draw the Line $\odot$ D, so it will be at right Angles to AB, as was required.



PROB. IV. To erect a Perpendicular at the End of a given Line.

Let the given right Line be AB, and from the End B, let it be required to erect a Perpendicular, as BE.



Open your Compasses to any convenient Distance, as BC, and draw the Arch CD; lay a Ruler to C and D, and draw the dotted Line CDE, as long as you please; take the Distance CD in your Compasses, and set from D to E, where you may, if you please, strike an Arch, and where it cuts the Line CE, which is in E, there lay a Ruler to B, and draw BE, which shall be perpendicular to AB, as was required.

PROB. V. To draw Lines parallel to each other.

Parallel Lines are those that being continued ever so far will never meet.

Let the Line given be AB, unto which I would draw a parallel Line. Open your Compasses to any convenient Distance, and



set one Foot in A, draw an Arch at C, and carry this Extent to B, then draw the Arch at D, lay a Ruler to touch the Arches C and D, and draw the right Line CD, which is parallel to AB, as was required.

N. B. There is a Ruler sold at the Mathematical Instrument-Makers, which greatly supplies the Use of this Problem, known by the Name of the Parallel Ruler, which I recommend to all my Readers as very useful,

PROB.

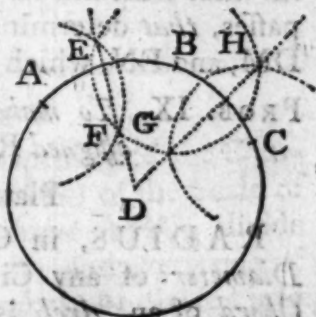
PROB. VI. *To draw parallel or concentric Circles.*

The Word *concentric* signifies having *the same* Center, and several Circles drawn from the same Center are said to be *concentric*: therefore set one Foot of your Compasses in C the *Center*, and open the other Foot to the Distance of your Circle intended, and draw a Circle; keep the Foot of your Compasses in the same Center, and open the other to the distance of *another* Circle, which draw, and do so by as many as you intend, as is more clear by the Figure.



PROB. VII. *To find a lost Center, which is the same as to find a Center that will pass through any three Points not in a right Line.*

Let the *three* Points given be A B and C, through which I would draw a Circle. Set one Foot of the Compasses at A, and open them to any Extent *more than half* the Distance AB, and draw the Arch EF; carry the *same* Extent of the Compasses, and set one Foot in B; draw the Arch EGH, with the *same* Extent; set one Foot in C, and draw the Arch HG; lay a Ruler to EF, and draw the Line ED continued at Pleasure; lay a Ruler to HG, and draw the Line HD, and it will meet with ED, in D *the Center* of the Circle, from which



which Center draw a Circle with the Distance D A, and it will pass through the three given Points A B C, as was required.

PROB. VIII. Three Points, *not in a right Line*, given to make a geometric Square.

Let the *three Points* given be A B C; thro' the Point B draw the Line F I, set one Foot of the Compasses in the Point A, and draw the Arch F G; set one Foot of the Compasses in the Point C, and draw the Arch H I; set one Foot of the Compasses in H and I *severally*, and draw the two Arches at L; set one Foot in F and G *severally*, and draw the two Arches at K; lay a Ruler to L and C, and draw a Line *with the Point of your Compasses*; lay a Ruler to K and A, and draw another Line *with the Point of your Compasses*; then take D E in your Compasses, and set one Foot thereof in D and E *severally*, and draw the Arches at M and N, and where those Arches cut that Line drawn with the *Point of your Compasses*, that determinates the Length of the Lines D M, and E N, which draw *with Ink*, and it is done.

PROB. IX. To make a Line of Chords to any assigned Radius or Length.

Plate 2. Fig. 1.

RADIUS, in Geometry, signifies *half* the Diameter of any Circle equal to C B; and the Chord of an Arch is like the String of a Bow, *i. e.*

i. e. it is a Line drawn from *any Point* in the Circumference of a Circle, to *any other Point* in the same Circle, as the Lines B 10, B 20, B 30, B 40, B 50, B 60, B 70, B 80, B 90, are the Chords of their respective Arches.

First, draw the *Quadrant* BC 90, and divide the Arch into 90 *equal Parts*, which number with 10, 20, 30, &c. to 90 *Deg.* set one Foot of your Compasses in B, and draw the Arch 90 A 90, so shall the Line AB be the *Chord* of 90, to the *Radius* CB; because all the *Chords* in the *Arch* B, 10, 20 and 90, are carried into the streight Line AB; set one Foot of the Compasses again in B, and carry the *Degrees* in the *Arch* into the Line AB, and number them with 10, 20, 30, &c. from B to 90 at A, so shall you have a *Line of Chords*, and thus may you make one of what Length you please.

PROB. X. To draw a Line, or Scale, of six Hours.

Plate 2. Fig. 2.

With any convenient Opening of the Compasses, draw the *Quadrant* ABC, divide the *Arch* into six equal Parts, and draw the *Chord* AC; lay a Ruler to the Center B, and to every Division in the Arch, and it will divide the *Chord* AC into a Scale of six Hours. See the Figure.

PROB. XI. To make a Scale of Inclination of Meridians.

Plate 2. Fig. 3.

With the same *Radius*, or Opening of the Compasses, that you drew the *Quadrant* of the Scale of the six Hours, draw the *Quadrant* ABC; divide the Arch into nine equal Parts, and every one of them into ten, so will the *Quadrant* be divided into 90 equal Parts, or Degrees; then draw the *Chord*

B 4

AC;

AC; lay a Ruler to the Center B, and to every Division in the Arch, and it will divide the Chord AC into a Scale of Inclination of Meridians, equal to that of the Scale of six Hours.

PROB. XII. To make a Line or Scale of Latitudes.

Plate 2. Fig. 4.

To proportion this Scale to the other two last mentioned, the Scale of Latitudes must be the Chord of 60 Deg. to the same Circle, in which the Scale of six Hours is the Chord of 90 Deg.

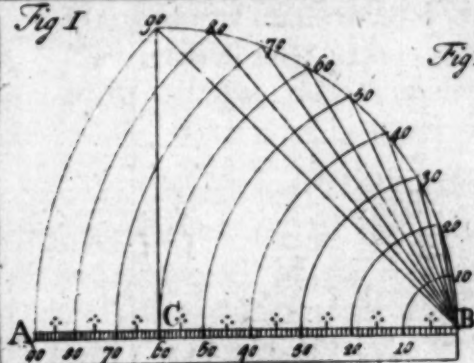
In either of the Problems X or XI, set one Foot of the Compasses in H, and take the nearest Distance to the Chord AC, with that Extent draw the Semi-circle DIF, and divide the Quadrant DI into 90 equal Parts or Degrees, and number them with 10, 20, 30, &c. to 90; then, by Prob. V. or rather with your Parallel Ruler, draw the Lines 10a, 20c, 30e, &c. parallel to DE; lay a Ruler to D, and to a, c, e, g, i, l, p, and I severally, and draw Dab, Dcd, Def, Dgh, Dik, Dlm, Dno, Dpq, and DI, and setting one Foot of the Compasses in F, carry the Points b, d, f, h, k, m, o, q, and I, into the Line FG, and number it with 10, 20, 30, 40, 50, 60, 70, 80, 90, which shall be a Line of Latitudes to the given Radius. Lastly, carry the Points 10, 20, 30, 40, 50, 60, 70, 80, 90, in the Arch DI, into the Line DH, and that shall be a Line of Chords, answering the Line of Latitudes, Inclination of Meridian and Hours.

PROB. XIII. To make a Quadrant.

A QUADRANT is a very useful Instrument in Dialling, and is the fourth Part of a Circle, of any Opening of your Compasses, whatever you please.

The

Fig I



A Line of Chords

Plate 2

The Different Scales
used in Dialling

Fig II

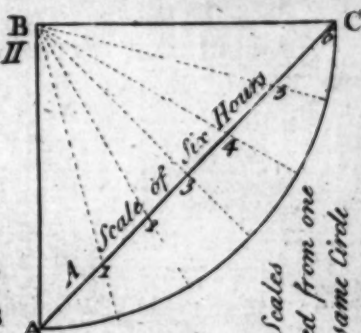
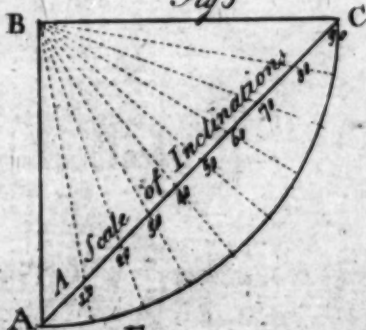
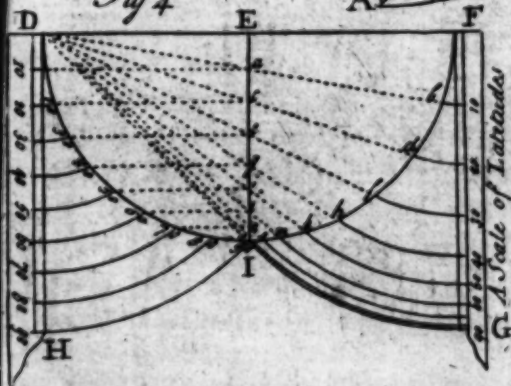


Fig 3



NB These four Scales
are all Projected from one
Radius of the same Circle

Fig 4



A Line of Chords

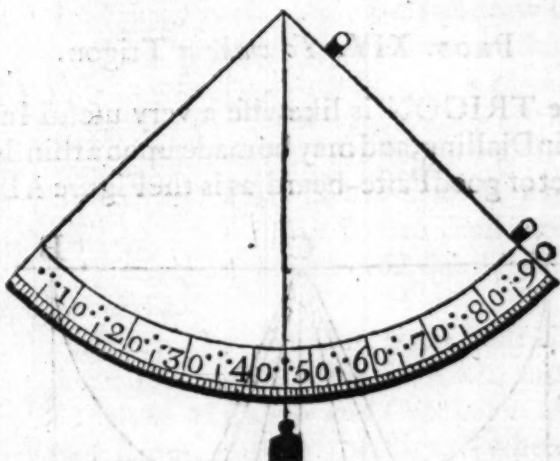
A Scale of Latitudes

A Scale of Six Hours

A Scale of Inclination of Meridians



The *Limb* or *Arch* thereof is divided into 90 equal *Parts*, called *Degrees*, and numbered with 10, 20, 30, &c. to 90. It has on one *Edge* two *Sights*, as



the annexed Figure. There are two Sorts commonly sold in *London*, known by the Name of *Gunter's* and *Collins's* Quadrants, which have Lines of *Hours* and *Azimuth* drawn on the *Face*, to shew the *Hour* of the Day or Night, and the *Azimuth* of the Sun, at any Time, for the Latitude of *London* only.

N.B. If you buy either of these Quadrants, and take them far *North* or *South* from *London*, they will there be of no Service to you in finding the *Hour* and *Azimuth*, || but only in taking an *Altitude*, and other Purposes in Dialling, as will be shewn in its proper Place.

If you procure a good seasoned Board that will not

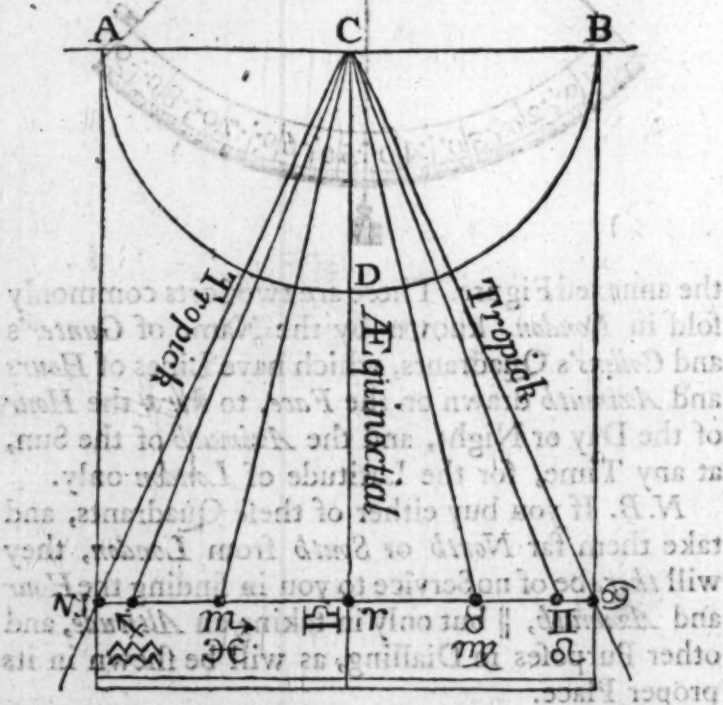
|| Those that would draw the *Hours* and *Azimuths* on a Quadrant, to any particular Latitude, may have Recourse to my *System of Astronomy*, Vol. I. where they will find full Directions for those Purposes.

warp,

warp, and thereon paste a Sheet of good Paper, and draw such a *Quadrant* as above represented, and fix thereto a *Thread* and *Plummet*, it will serve your Purpose well enough.

PROB. XIV. *To make a Trigon.*

The **TRIGON** is likewise a very useful Instrument in *Dialling*, and may be made upon a thin Board, or Sheet of good Paste-board, as is the Figure *AB* ∞ *yz*,



of any convenient Size you please. At right Angles to *AB*, draw *CD* ∞ , which shall represent the *Equinoctial*; with the *Chord* of 60 Degrees, draw the *Semicircle* *ADB*; take in your *Compasses* from the *Line of Chords* (*Plate 2. Fig. 1.*) 11 Deg. 30 Min. (for

(for such is the Sun's Declination when he enters γ North, and π South) and set one Foot in the Point D, that is, where the *Equinoctial* C D γ cuts the *Semicircle*, and turn the other Point *each Way* upon the Arch, there make Marks, and draw C γ π , and C π γ : These two lines shall represent the Sun's Declination in the *Trigon*, when he enters *those Signs*. Take 20 Deg. 11 Min. from your *Line of Chords*, (Plate 2. Fig. 1.) and set it from D, *each Way* upon the Arch, and thro' *those Points* draw C π γ , and C γ π , these two Lines in the *Trigon* shall represent the Sun's Declination North and South, when he enters *those Signs*. *

Lastly, take 23 Deg. 29 Min. from your *Chords*, and set it from D *each Way* upon the Arch, and draw the two Tropicks of Cancer and Capricorn. At the End of *those Lines*, close by the Signs (where you see the Dots) you must make small Holes, through which to put a Thread; and thus is your *Trigon* finished, and fitted for the inserting of the *Parallels* of the *twelve Signs*, into all Sorts of Sun-Dials, either *direct* or *reclining*. † But if you would put in other *Parallels* of Declination, such as when the Days are just 8, 9, 10, 11, 12, 13, 14, 15, or 16 Hours long, then you must insert into your *Trigon* such Degrees of Declination as the Sun hath, when the Days are so many Hours long, as you would describe upon your Dial; and so in the Latitude of London,

* The Sun's Declination is his Distance either North or South from the *Equinoctial*. N. B. It is North from the 21st of March to the 22d of September, and the rest of the Year it is South. See Table I.

† The *Parallels* of the 12 Signs are the Sun's Declination that Day that he enters any Sign; as for Example, *Taurus* 11 Deg. 30 Min. as you find it in Table I.

When

				Deg.	Min.	
When	8	} or {	16	Hours	21	40
the	9		15	long,	16	55
Day is	10		14	the sun	11	37
either	11		13	hath	5	55
						Of Declination.

N. B. By the 25th Prob. of my *System of Astronomy*, Page 146, you may find these Declinations for any other Latitude.

CHAP. II. Of DIALLING in General.

DIALLING is a very *curious and useful Art*, and teacheth us how to draw *Hour-Lines* upon all Sorts of *Surfaces* or *Planes*, for any Place in the World, and thereby to know the apparent Hour of the Day, by the Shadow of a *Stile** fixed on the Plane *parallel to the Earth's Axis*, which *Stile* can have no more than *three Positions*, viz. *Perpendicular*, *Oblique*, or *Parallel*, which shall be shewn in their proper Places.†

A *Dial-Plane* is that Flat on which a Dial is intended to be projected.

The *Dial-Planes*, on which Hour-Lines are drawn, are these following :

* The *Stile* in Dialling signifies the Pin or Cock of a Dial, the Shadow of which points out the Hour.

† The whole Business of Dialling may be reduced to *three general Heads*: the *first* consists in finding the Place of the *Substile*, or where the *Stile* is to be placed; the *second* in drawing the *Hour-Lines*; and the *third*, and last, if the Dial-Plane be *moveable*, in duly placing and fixing the same; after the Dial is drawn thereon; or else, if the Plane, whereon the Dial is to be drawn, be *unmoveable*, and already fixed, in finding the *Position* or Situation of the said Plane, viz. whether it be a *direct* or *declining* Plane, and if the latter, how far it declines.

The

The Horizontal
 The North and South erect direct
 The erect Decliner
 The Reclining Inclining
 The Reclining Declining
 The Convex
 The Concave

} Dial-
 Plane.

The *Equinoctial* Dial-Plane is that which is *parallel* to the Plane of the *Earth's Equator*, and is *universal*; for Hour Lines drawn thereon, will shew the apparent Time of the Day in any Place of the World; and because this is the *Ground and Foundation* of all other Dials, therefore I shall begin *first* with it, and, in the Course of this Work, shall shew how naturally the *Hour Lines*, upon all Sorts of Dial-Planes, are deduced from the *Equinoctial* Dial; but shall *first* furnish you with the following Table.

*A new correct alphabetical Table of the principal CITIES and TOWNS in England, Scotland, Ireland, and Wales, * shewing at each Place the Elevation of the Pole, and Difference of their Meridians from London.*

✂ The *Elevation of the Pole* signifies the same as the *Latitude of the Place*; and the *Difference of Meridians*, the same as the *Longitude of the Place*.

NOTE.

D } signifies { Degrees	E	} signifies {	East	} Longitude.	
H } { Hours	W		West		
M } { Minutes	N		North		} Latitude.
	S		South		

* N.B. There is a Table of the most eminent *Cities and Towns in the World*, in *Chapter XXIV.* near the latter End of this Work.

England.

14 *A new Table of the Elevat. of the Pole, and*

		<i>Latit. Diff. Merid.</i>				<i>Latit. Diff. Merid.</i>	
<i>England.</i>		<i>D. M.</i>	<i>H. M.</i>			<i>D. M.</i>	<i>H. M.</i>
B		51 25N	0 8W	Nottingham		52 17N	0 4W
BATH		52 6N	0 2W	Ormskirk		53 30N	0 12W
Bedford		55 45N	0 7W	Orfordness		52 14N	0 6E
Berwick		51 26N	0 11W	Oxford		51 45N	0 5W
Bristol		51 57N	0 4W	Penzance, Corn-			
Buckingham		52 12N	0 0W	wall		50 8N	0 24W
Cambridge		51 16N	0 5E	Peterborough		52 33N	0 1W
Canterbury		54 48N	0 10W	Portsmouth		50 48N	0 5W
Carlisle		53 10N	0 12W	Preston, Lanca-			
Chester		50 52N	0 3W	shire		53 42N	0 11W
Chichester		51 57N	0 4E	Richmond, in			
Colchester		52 26N	0 6W	Yorkshire		54 20N	0 6W
Coventry				Rochester, Kent		51 23N	0 3E
Cronton in				Salisbury		51 7N	0 8W
Lancashire		53 22N	0 12W	Shrewsbury		52 42N	0 11W
Derby		52 58N	0 6W	Southampton		50 53N	0 6W
Dorchester		50 43N	0 11W	Stafford		52 45N	0 9W
Dover		51 5N	0 5E	Stamford, Lin-			
Durham		54 47N	0 5W	colnshire		52 37N	0 1W
Exeter		50 49N	0 14W	Truro		50 10N	0 22W
Flamborough		54 9N	0 1E	Wigan		53 34N	0 11W
Falmouth in				Weymouth		50 37N	0 10W
Cornwall		50 9N	0 22W	Warrington		53 24N	0 10W
Gloucester		51 51N	0 9W	Warwick		52 18N	0 6W
Guildford		51 15N	0 3W	Wells, Somerset		51 15N	0 11W
Harborough in				Winchelsea		50 57N	0 3E
Leicestershire		52 27N	0 5W	Winchester, in			
Hereford		52 4N	0 11W	Hants		51 7N	0 5W
Hertford		51 48N	0 0W	Wolverhamp-			
Hull		53 46N	0 1W	ton		52 38N	0 9W
Huntingdon		52 18N	0 1W	Woodstock		51 50N	0 6W
Ipswich		52 8N	0 5E	Worcester		52 13N	0 9W
Kendall		54 13N	0 11W	Yarmouth, Nor-			
Lancaster		54 0N	0 11W	folk		52 44N	0 7E
Leicester		52 37N	0 5W	York		53 55N	0 4W
Lincoln		53 13N	0 2W				
London		51 32N	0 0W				
Liverpool		53 25N	0 12W				
Litchfield		52 42N	0 7W				
Manchester		53 28N	0 9W				
Newcastle upon							
Tyne		55 1N	0 5W				
Northampton		52 12N	0 4W				
Norwich		52 42N	0 6E				

* Mr. Norwood, in his *Seaman's Practice*, Page 26, makes the Latitude of London 51 D. 30 M. and of York 53 D. 38 M. consequently the Difference of Latitude between them is 2 D. 8 M.

Cardiff



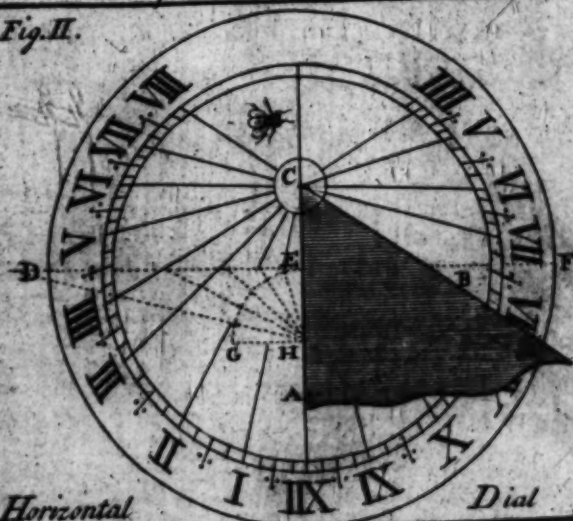
Fig. I.

Plate 3



An Equinoctial Universal Dial

Fig. II.



Horizontal

Dial

Diff. of Merid. for Great-Britain, Ireland, &c. 15

	Latit. Diff. Merid.				Latit. Diff. Merid.				
	D. M.	H. M.			D. M.	H. M.			
Cardiff	51	42 N	0	13 W	Dumblain	56	14 N	0	16 W
Cardigan	52	8 N	0	19 W	Dunkeld	56	37 N	0	13 W
Denbigh	53	10 N	0	14 W	Edinburgh	55	57 N	0	12 W
Flint	53	12 N	0	13 W	Glasgow	56	20 N	0	17 W
Harlech, in Merionethshire	52	53 N	0	17 W	Leith	54	58 N	0	12 W
Landaff	51	43 N	0	13 W	Orkney	60	6 N	0	14 W
Milford	51	43 N	0	20 W	St. Andrews	56	19 N	0	10 W
Monmouth	51	50 N	0	11 W	Stirling	56	10 N	0	15 W
Montgomery	52	34 N	0	13 W					
Pembroke	51	42 N	0	20 W	Ireland.				
Radnor	52	21 N	0	12 W	A Ntrim	54	47 N	0	26 W
St. Asaph	53	15 N	0	13 W	Ardglas	54	19 N	0	24 W
St. Davids	55	1 N	0	21 W	Armagh	54	22 N	0	28 W
Welshpool	52	40 N	0	13 W	Belfast	54	36 N	0	27 W
Wrexham	53	2 N	0	13 W	Caterlagh	52	48 N	0	29 W
					Clare	52	41 N	0	37 W
British Islands.					Cork	51	45 N	0	36 W
Anglesey-Middle	53	20 N	0	18 W	Colerain	55	8 N	0	28 W
Guernsey	49	36 N	0	11 W	Drogheda	53	43 N	0	26 W
Jersey	49	28 N	0	14 W	Dublin	53	16 N	0	26 W
Lundy	51	20 N	0	15 W	Dundalk	54	3 N	0	27 W
Man	54	25 N	0	18 W	Galloway	53	12 N	0	32 W
Portland	50	30 N	0	11 W	Kent	52	39 N	0	30 W
Wight	50	37 N	0	6 W	Kildare	53	8 N	0	29 W
Yarmouth in ditto	50	44 N	0	7 W	Kinsale	51	31 N	0	38 W
					Londonderry	54	55 N	0	32 W
Scotland.					Limerick	52	36 N	0	31 W
Aberdeen	57	6 N	0	7 W	Maryborough	53	0 N	0	31 W
Dunbar	55	57 N	0	9 W	Philips town	53	15 N	0	32 W
Dundee	56	30 N	0	13 W	Tuam	53	26 N	0	37 W
					Waterford	52	13 N	0	29 W
					Wexford	52	19 N	0	27 W
					Youghall	51	51 N	0	33 W

CHAP. III. *To make an Equinoctial* Dial.*

Plate 3. Fig. 1.

THIS Dial, of all others, is the most simple and easy to be drawn, and is thus made:

• *Equinoctial Dials* are those whose *Plane* or *Face* lieth parallel to the Equinoctial.

Take

Take a *flat* Plate of Brass, about a Foot square; or if you cannot easily procure Brass, get a Piece of good dried Oak, well planed on both Sides.

For the Hour Lines.

Draw with your Compasses *three* $\dagger$ *concentric* Circles thereon, to contain the Figures, which divide into 24 *equal* Parts; then lay a Ruler to the Center, and draw Lines to those *equal* Divisions in the Circle, and they shall be the true *Hour Lines* sought.

For the Stile.

Erect in the Center of the Plate a Pin or Wire *perpendicular* to the Plane, as A B, and that shall be the *Stile* truly fitted to the Dial.

You must observe, that 15 *Deg.* $\parallel$ in the *Equinoctial* is *one Hour in Time*, as you may see more at large by Table III. and therefore, if you take 15 *Deg.* from your *Line of Chords*, and set it off from the 12 o-Clock Line *each Way*, that will give you the Hours of 11 and 1, and 30 *Deg.* will give you the Hours of 10 and 2, &c. and thus the whole *equinoctial Circle* will be divided into 24 *equal* Parts or Hours, as above.

But because this Dial, when thus drawn on *one* Surface or *Side* of the Plane, will serve only for one Half of the Year, *viz.* while the Sun is on *one Side* of the *Equinoctial*, to wit, from the 22d of March to the 22d of September; and therefore to make it

$\dagger$ See Problem VI. Page 5.

$\ddagger$ Throughout this Book you will find continual Mention made of *Degrees and Minutes*, therefore you are to remember, that a *Degree* is the 360th Part of any Circle; each of which Degrees is supposed to be divided into 60 Minutes; so that 45 Minutes is *three Quarters* of a Degree, 30 Minutes *Half* a Degree, and 15 Minutes a *Quarter* of a Degree, &c. See Table III.

serve for the *whole Year*, it must be *doubly drawn*, *i. e.* on the *lower*, as well as on the *upper Side* or Surface of the Plane, and then the Wire, which serves for the *Stile*, must go through the *Center*, and must extend itself 6 or 8 Inches more or less *beyond* the Surface of the Plane, and stand at *right Angles* therewith; and then that Dial is *finished*. How naturally the *Hour Lines* of all Dials are drawn from the *Equinoctial Dial* is shewn in Chapter XXI.

To set this Dial truly.

You must raise the Wire, which represents the *Stile*, to the *Latitude* of your Place, by applying that Edge of your *Quadrant*, in which the Sights are fixed, to the *Stile*, and when the *Thread* cuts the *Limb* in the *Degrees* of the *Latitude* of your Place, then doth the *Stile* point to the *Poles of the World*, and the Dial itself lieth *parallel* to the *Equinoctial Circle* in the Heavens. But still here wants a *true 12 a-clock Hour Line*, which must be found as I shall shew in the next Chapter, and then placing the Dial, so that at *12 a-clock* the *Shadow* of the *Stile* may fall in the *12 a-clock Hour Line*, that you find by the Directions following: and thus will your Dial be *truly placed*, which you may fasten by fixing two Pieces of Iron at each End of your *12 a-clock Hour Line* upon your *Dial Post*, and in those put the *Stile* of the Dial to the *Height*, which was found before by the Help of your *Quadrant*.

CHAP. IV. To make an Horizontal * Dial.

Plate 3. Fig. 2.

THIS is the most *useful* Dial of all others, because the Sun stayeth upon it from his *Rising* to his *Setting*, in all *Places*, of the *World*, wheresoever you be.

It matters not what *Form* the *Plane*, on which you would draw an *Horizontal Dial*, is, whither it be *round*, *square*, or *triangular*, but they are generally drawn *round*, as on *Plate 3. Fig. 2.* in which, when you have drawn *three concentric Circles*, as a *Margin* to contain the *Figures*, draw the *Line CA*, which shall represent the *12 a-clock Line*, and also the *substilar Line*, in which make choice of a *Point*, as at *C*, a little above the *Center* (for by that *Means* you will enlarge the *Distances* of the *Hour Lines*) and through it draw the *Line VI. C. VI.* for the *6 a-clock Hour Line*. In the *substilar Line*, † as at *E*, make choice of *another Point* and through that, at *right Angles* to the *12 a-clock Line*, draw the *Line DEF*; having proceeded thus far, let it be required to make an *Horizontal Dial* to the *Latitude* of *Durham*, which is *54 Deg. 47 Min. North*; open your *Compasses* to the *Chord* of *60 Deg.* set one *Foot* in *C*, draw the *Arch AB*, and take the *Chord* of *54 Deg. 47 Min.* and set it from *A* to *B*, and draw the *Line CB* for the *Stile*, so is *ACB* the

* *Horizontal Dials* are those whose *Plane* or *Face* lies parallel to *Horizon* of the *Place*.

† The *substilar Line* in *Dialling* is that *Line* drawn upon the *Plane* or *Face* of the *Dial*, over which the *Stile* stands perpendicular, or at *right Angles*. *Note*, This is not the *12 a-clock Line* in all *Dials*, tho' it is in the *Horizontal*, and *South* and *North Erect Direct* *Dials*.

true

true Form and Shape of your *Dial Cock* or *Stile*; set one Foot of your Compasses in E, that is, where the Line DEF cuts the 12 *a-clock* Line, and take the nearest Distance to the Line CB, or *Stile's Height*, turn that Point of your Compasses about, and make another Mark in the 12 *a-clock* Line at H; this Point H represents the *Center* of the Equinoctial. On H, as a *Center*, draw the *Quadrant* GE, and divide it into six equal Parts; lay a Ruler to H, and to those equal Parts in the Arch severally, and where the Ruler cuts the Line DEF, the Points are through which the *Hour Lines* must pass; then lay a Ruler to the *Center* at C, and to those Marks in the Line DEF, and draw the *Hour Lines*; set off the same Distances in the Line DEF, from E towards B, and draw the *Morning Hours*; those before six in the Morning and after six at Night, are drawn by continuing the same *Hour Line* beyond the *Center* C.

To set it truly.

The Dial being thus finished, the next Thing is to set it truly; for if it be ever so truly made, and not well set, it will go wrong: therefore you must first see that your Post, on which the Dial is to stand, be truly level every Way, which you may try by your *Quadrant*, on which draw a Circle as large as the Top of the Post will bear; in the *Center* thereof place a Pin exactly upright; in the Forenoon, when the Sun shineth, let the End of the Shadow of the Pin touch the Circle, where make a Mark; let Things stand thus till Afternoon the same Day, and then observe where the Top of the Shadow of the Pin toucheth the same Circle; there again make a second Mark; then divide the Distance of these

two Marks into two equal Parts, and from that through the Center draw a Line, which shall be the 12 a-clock Hour Line, and set the 12 a-clock Line of your Dial upon this 12 a-clock Line on the Post; so shall your Dial be truly placed, which may be fastened at your own Discretion.

Note, Instead of the Quadrant GE, you may draw a Semicircle on the Center H, and divide it into 12 equal Parts, and so Lines drawn from the Center at H will give the Points in the Line DEF, as before. Or, if you apply the Center of the Equinoctial Dial to the Center at H, the Hour Lines on the Equinoctial Dial will cut the Line DEF in the Points where the Hour Lines on the Horizontal Dial must pass.

☞ *For drawing the Half Hours and Quarters, upon all Sorts of Dials, you are to observe, that as you divided the Circle, which represented the Equinoctial (into 24 equal Parts) for the Hours, so you are to divide each of those Parts into 4 equal Parts more, and those will be the Quarters.*

N. B. That in placing of Dials, when made, excepting the Equinoctial and Horizontal Dial, you have no Occasion to regard the Place where they are to be fixed, for the Hour Lines being drawn according to the Destination or Reclination of the Place, it gives you the true Situation of the Dial itself.

CHAP. V. *To make an erect * direct South Dial.*

Plate 4. Fig. 2.

THIS Dial Plane is no more than an upright Wall, which exactly faces the true South Point.

As

* 1. Those Planes are said to be erect or upright, which stand perpendicular to the Horizon of the Place; and such are the Walls of Churches, Houses or the like, against which, for the most Part, Dials are placed.

2. Of

Chap. V. Of the erect direct South Dial. 21

As the *Elevation of the Pole* above the *Horizontal Plane* was equal to the *Latitude of the Place*: so in this it is the *Complement of the Latitude* of the Place, or what it wants to make it up 90 Degrees.

The Sun never stays 12 Hours upon this Plane, but when in the *Equinoctial*; because the Plane itself lieth in the *prime Vertical*, or *East and West Azimuth*; for, from *March 20*, to *September 23*, he doth not come due East till after 6 in the Morning, and is due West before 6 at Night: so that when in the Tropic of ϖ he is due East at 7H. 20M. 48 S. and due West at 4H. 39M. 12S. consequently his Stay then upon the Plane is only 9 H. 18 M. 24 S. See my *Astronomy*, P. 104.

For the Hour-Lines.

When you have made choice of your Plane, draw the *Horizontal Line* VI, VI, for the *East and West Line*, or *Hour Line* of Six; from A let fall the *Perpendicular* A F, for the 12 a-clock *Hour Line*; then with your Compasses take 60 Deg. from the *Line of Chords*, and draw the *Arch* BC VI; take the *Complement of the Latitude* of your Place, which, in this Example, I'll suppose to be *Chester*, whose *Latitude*, as you find it in the Table, is 53 Deg. 10 Min. North, and set 36 Deg. 50 Min. its *Complement*, or what it wants to make it up 90 Degrees from B to C; draw A C for the *Height of the Stile*.

2. Of these erect or upright Planes there are two Sorts, viz. *Direct* and *Declining*. 3. Those erect or upright Planes are said to be *direct*, which directly face the East, West, North, or South Points of the Horizon, and these are called *erect direct Planes*. 4. Those erect or upright Planes are said to *decline*, which do not directly face the East, West, North, or South Points, but look upon some other Points situate betwixt them, viz. *South-East*, *North-West*, *North-East*, &c. and these Planes are called *upright or erect, declining Planes*. How the Declination is to be found, is taught in Chap. X.

Make choice of any Point, at Pleasure, in the 12 a-clock Line, as I; through I, at right Angles to the 12 a-clock Line, draw the Line DIE; set one Foot of your Compasses in I, and take the *nearest Distance* to the Height of the Stile AC, and turn that Point of your Compasses down to F, and there make a Mark in the 12 a-clock Line, on which Point F describe the Semicircle GIH, and divide it into 12 equal Parts, for that Semicircle represents *one Half* of the Equinoctial; lay a Ruler to F, and to those Marks in the Semicircle just now made, and draw Lines from thence to the Line DIE. Lastly, draw Lines from A to those Marks in the Line DIE, and they shall be the true Hour Lines upon your Dial's Plane.

For the Quarters.

The Quarters are drawn in like Manner, by dividing the Semicircle into 48 equal Parts, so that *one Quarter* will be 3 Deg. 45 Min. *two Quarters* 7 Deg. 30 Min. and *three Quarters* will be 11 Deg. 15 Min. as you may see by Table III.

Having thus finished the Hour Lines, place 12 at the End of the Line AF, and if it is a South Dial, as specified above, and your Face toward it, you must place the Morning Hours on the left Hand, and the Afternoon Hours on the right, as you see done in the Figure.

For the Stile.

If your Plane be large, it will be best to get an iron Rod, about the Thickness of your Hour Lines, for the Stile, and be sure to place it exactly over the 12 a-clock Hour Line, and to make an Angle with your Plane equal to the Complement of Latitude, which

Chap. VI. *Of the erect direct North Dial.* 23
 which is done by applying the Edge of your Quadrant
 to it, and so fix it, when you find it stands true.

For the Thickness of the Stile.

☞ Be sure you always mind to make Allowance
 for the *Thickness of the Rod* which is to be the
Stile, and this is to be done when you draw the
Semicircle GIH, by having *two Centers* at *F*, di-
 stant *just the Thickness of the Stile*; otherwise, if
 this Care be not taken, your Dial will go too *slow*
 in the *Forenoon*, and too *fast* in the *Afternoon*.

CHAP. VI. *To make an erect direct North Dial.*

Plate 4. Fig. 1.

THIS *Dial Plane* is no more than an *up-
 right Wall* that exactly faces the *true North
 Point*. This Dial is of no Use from *September* the
 22d to *March* the 21st, that is, while the Sun is
 in the *six Southern Signs*,* to us who inhabit the
Northern Hemisphere, because it only shews the
 Time from *Sun rising* to *six* in the *Morning*, and
 in the *Afternoon*, from *six* till *Sun setting*; for this
Dial, and the *South Dial*, make up the *Horizontal
 Dial*, i. e. takes in all the Hours of the *longest Day*;
 and as the *Stile* of the *South Dial* points down-

The Six Northern Signs are;

Aries	♈	Cancer	♋
Taurus	♉	Leo	♌
Gemini	♊	Virgo	♍

* The Six Southern Signs are,

Libra	♎	Capricorn	♐
Scorpio	♏	Aquarius	♑
Sagittary	♐	Pisces	♓

24 *Of the erect direct North Dial.* Chap. VI.
wards, so of the North the Stile points upwards,
and makes an Angle with the Plane equal to the
Complement of the Latitude of the Place, i. e. what
the Latitude of the Place wants to make up 90 Deg.

The making of this is the very same as the South
Dial; for having made choice of your Plane, draw
the Horizontal Line 6. A 6. for the East and West
Line; about the Middle, at A, erect the Perpendicular
AB, which shall represent the 12 a-clock Hour
Line (though the Figure 12 needs not be put to it.)

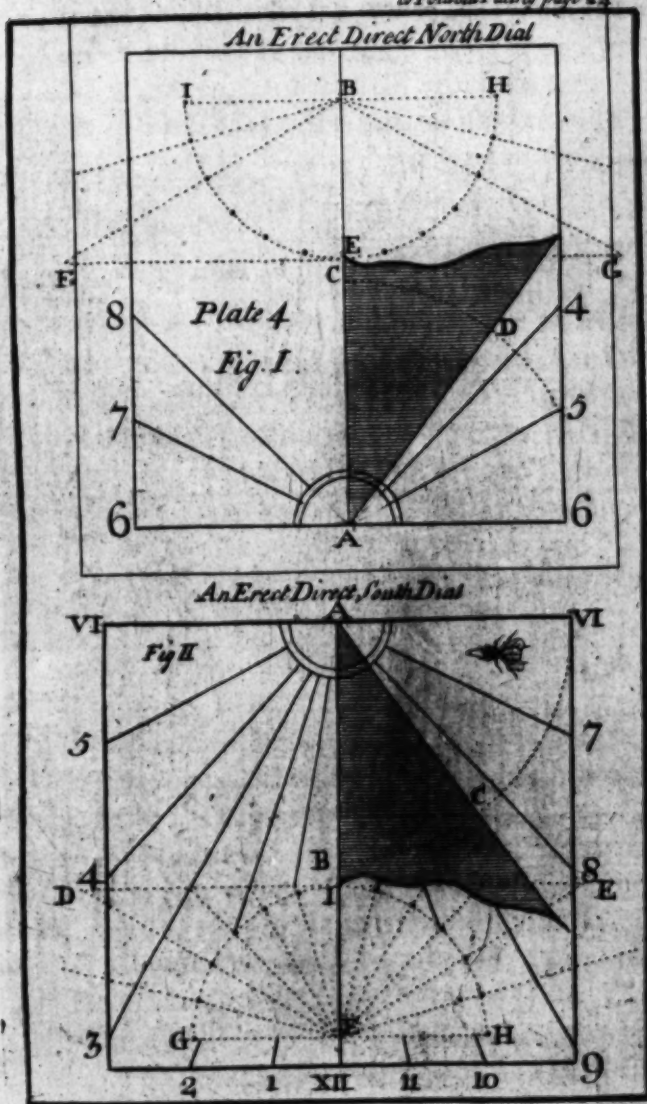
For the Stile's Height.

On the Point A, with the Chord of 60 Deg.
draw the Arch CD; take from your Chords the
Complement of the Latitude of your Place, as sup-
pose York 36 Deg. 5 Min. and set it from C to D;
then draw AD for the Stile's Height.

For the Hour Lines.

Make choice of any Point convenient for your
Purpose, in the 12 a-clock Line AB, as the Point
E, through which, at right Angles to the 12 a-clock
Line, draw the Line FEG; set one Foot of your
Compasses in E, and take the nearest Distance to
the Stile's Height AD; set that Distance from E
to B, so shall the Point B be the Center of the
Equinoctial; on B, with the Distance BE, draw
the Semicircle HEI, and divide it into 12 equal
Parts; lay a Ruler to the Center B, and to those
Marks in the Semicircle, and where the Ruler cuts
the Line FEG, are the Places where the Hour Lines
must pass, which must be drawn from the Center A.

On





On *this* Dial there is not any Occasion of drawing any more *Hour Lines* than 4 and 5 in the *Morning*, and 7 and 8 at *Night*.

For the Stile.

Over the 12 a-clock Line AB, at *right Angles*, fix the *Stile*, so that it may make an Angle with the Plane, equal to the *Complement of the Latitude of the Place*, which you must try by Help of your *Quadrant*, as has been before directed in the *South Dial*; and thus is the *North Dial* compleatly finished.

N. B. The *Quarters* and *Half Hours* are drawn as has been taught in *Pages 20 and 22*.

CHAP.VII. *To draw an erect direct East Dial.*

Plate 5. Fig. 1.

THIS Dial's Plane lieth in the Plane of the *Meridian of the Place*, i. e. is no more than an *upright Wall*, that exactly faces the *true East Point*. The *Hour Lines* are all *parallel to each other*, and to the *Axis of the World*, and consequently have *no Centers*; the Sun comes on it at his *Rising*, and continues thereon till *near Noon*.

The *six a-clock Hour Line* is the *Substilar Line*, over which the *Stile* is fixed at *right Angles*, and may be either a *thin Plate* of Iron, or a *perpendicular Wire*, &c. whose *Height* must be equal to the *nine a-clock Hour Line* in this Dial, and to the *three a-clock Hour Line* in the *West Dial*.

Having

Having then made choice of your Plane, *about one third* of the Distance from the *Bottom*, draw the *Horizontal Line* ACH; in some convenient Place, as at C, draw a Circle with the Chord of 60 Degrees sure; then take the Chord of the Latitude of the Place, as suppose at Oxford 51 Deg. 45 Min. and set from H to P, and draw PCS, which shall be the *Substilar Line*, and *six a-clock Hour Line*, to which at right Angles, draw CD for the *Equinoctial*.

Next draw the Line ASB, parallel to the *Equinoctial*, and divide the Quadrant SD into six equal Parts; lay a Ruler to the Center at C, and to those equal Parts in the Circle, and it will cut the Line AB in the Points where the *Hour Lines* must pass, through which Points, in the Line ASB, draw the *Hour Lines* parallel to the *six a-clock Hour Line*, which are the true *Hour Lines* from Six till Noon; the Hours of 4 and 5 in the Morning are the same Distance from 6 on one Side, as 7 and 8 are on the other.

The *Quarters* are drawn by subdividing the Divisions in the Circle into four equal Parts, as has been above directed.

Of fixing the Stile.

The *Hour Lines* being thus drawn, fix the *Stile* at right Angles on the *Substilar Line*, as before directed, and your Dial is compleatly finished.

This Dial is universal, by placing the Earth's Axis parallel to the Axis of the World, in what Latitude soever you be.

N. B. The Earth's Axis, in this Dial, is represented by the *six a-clock Hour Line*. See the Description of the Sphere. See also the End of Chap. XXI.

CHAP.

CHAP. VIII. *To draw an erect direct West Dial.*

Plate 5. Fig. 2.

THIS *Dial Plane* is no more than an *upright Wall* that exactly *faced the true West Point*.

The making of this is the very same, in all Respects, as making of the *East Dial*, only as the *East Hour Lines* are elevated to the *right Hand*, so here they are elevated to the *left Hand*.

The Hour of 12 can never come upon either the *East* or *West Dial Planes*, because at that Hour the Sun being upon the *Meridian*, the Shadow of the *Stile* will be *parallel* to the *Plane*, and consequently can cast no Shadow upon it.

For the Hour Lines and Substilar Line.

Then, having your *Plane* in Readiness, at about one Third of the Depth of the *Plane* from the *Top*, draw the *Horizontal Line* AH, and make choice of a convenient *Point* therein, as at C, and draw the *Circle* PHDS; take 50 Deg. 49 Min. from your *Line of Chords* (that being the Latitude of the City of Exeter) and set that Distance just now taken from your *Line of Chords*, from H to P; draw PCS for the *Substilar Line*, and *Hour of Six*. [2] And, at right Angles thereto, draw CD to represent the *Equinoctial*, and draw the *Line* BA to touch the *Circle* in S, parallel to CD. [3] Divide the *Quadrant* DS into six equal Parts, and lay a Ruler to the Center at C, and to each Mark in the *Quadrant* DS, and it will cut the *Line* BA in the Points where the *Hour Lines* are to pass. [4] Through those

those Marks, in the Line BA, draw Lines *parallel* to the *six a-clock Hour Line*, and they shall be the true *Hour Lines* upon the *Dial*. The Hours of 7 and 8 in the *Evening* are the *same Distance* from 6, that 5 and 4 are on the *other Side*.

For the Quarters and Half Hours.

The *Quarters* and *Half Hours* are drawn in both these *East* and *West* *Dials*, by *dividing* each *sixth Part* of the *Quadrant DS* into *four equal Parts*, and carrying them into the *Line AB*, by laying the *Ruler* to the *Center C*, and to *those Parts* in the *Arch DS*, as you were taught in drawing the *Hour Lines*.

For fixing the Stile.

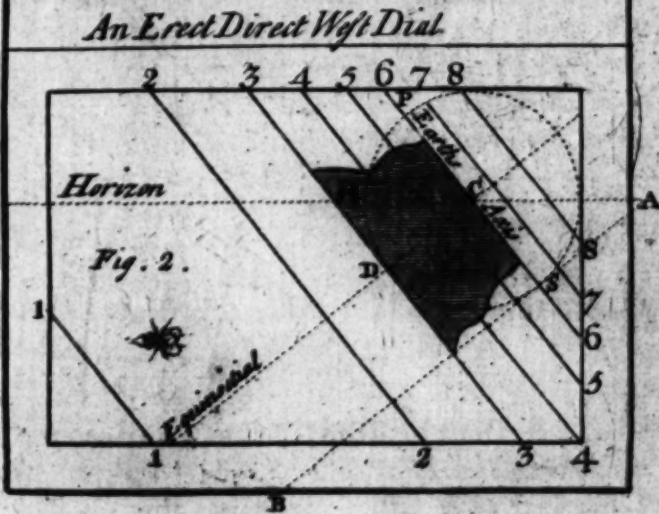
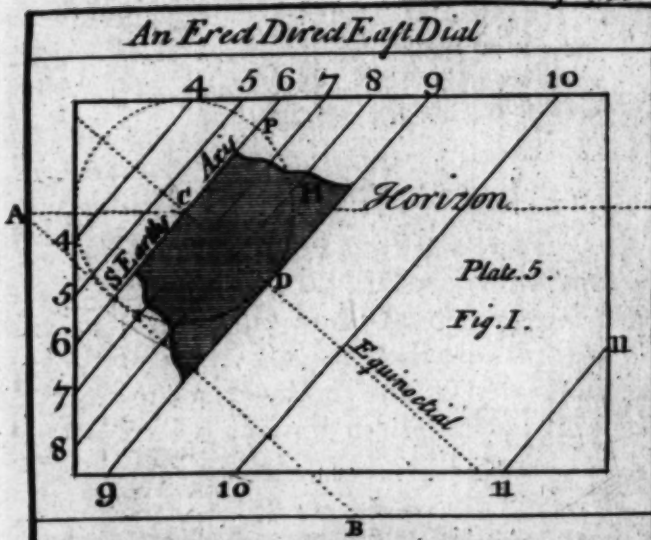
Fix the *Stile* upon the *six a-clock Hour Line*, and at *right Angles* thereto, which may be a *Plate* of *Copper*, *Brass* or *Iron*, as in *Plates 5* and *6*, whose *Height* must be *equal* to *CD*, or the *three a-clock Hour Line*, and then is your *Dial* finished.

See also the *End of Chapter XXI*.

CHAP. IX. To make a Polar Dial.

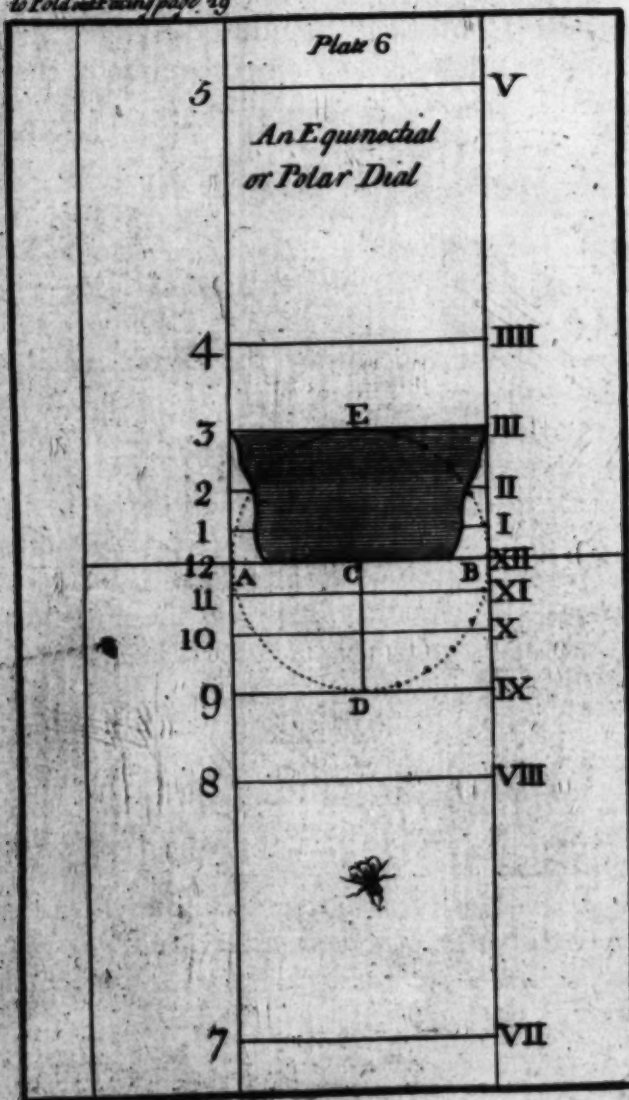
Plate 6.

THIS Dial is called by some Authors an *Equinoctial Dial*, and by others a *Polar Dial*; but, be that as it will, it is plain, that all Places, lying under the *Equinoctial* have no *Latitude*; as for Instance, the *Island of St. Thomas* has no *Latitude*.









tude, for which this *Dial* is made, and for that Reason the *Hour Lines* cannot have any *Center*; and therefore all the *Hour Lines* drawn upon these *Dials* will be *parallel* to each other.

For the Hour and Substilar Lines.

 [1] To draw the *Hour Lines* upon this Plane, first draw AB for the *Substilar Line* and *Hour Line* of XII. [2] On C, as a *Center*, with the *Chord* of 60 *Deg.* draw the *Circle* AEBCD, and draw the two Lines, V. VII. and 5. 7. divide the *Semicircle* EBD into 12 equal *Parts*; lay a *Ruler* to the *Center* of the *Circle* at C, and to each *Mark* in the *Circle*, and it will cut the Line V. VII. in the *Points* where the *Hour Lines* must pass. [3] *Through* which *Points* draw *Hour Lines* parallel to AB, and they shall be the *true Hour Lines* that were required.

For the Stile.

The *Stile* may be a broad *Plate* of *Copper*, *Brass* or *Iron*, at *Pleasure*, placed at *right Angles* over the 12 *a-clock Hour Line*.

The *Hour Line* of *six* never falls upon this *Dial*, because under the *Equinoctial* the *Sun* rises and sets at *Six* the *Year* throughout, with very little *Variation*.

CHAP. X. *To find the Declination * of a Wall or Plane whereon to draw a Sun-Dial.*

Plate 7. Fig. 9.

A Description of the Instrument.

[1] **P**ROCURE an oaken Board (which at London they call Wainscot) about a Foot square, more or less, it matters not; take ABCD, about an Inch thick, well planed on both Sides, and thereon paste a Sheet of good Paper very smooth, on which draw two or three concentric Circles, it matters not how many, nor at what Distance they be. [2] In the Center I, let there be an Hole to receive a straight Wire to screw up and down at Pleasure, and to stand at right Angles to the Board itself; draw two Diameters, and mark them with the Letters of the four cardinal Points, East, West, North and South, which Line NS represents the Axis of the Wall, i. e. it stands perpendicular, or at right Angles, to the Wall itself; and if it doth not decline from the South or North, nor yet to the East or West, the said Line also represents the 12 a-clock Hour Line.

To take the Declination.

[3] When you would take the Declination of a Wall, apply the Edge of the Instrument AB to the Wall; and in the Forenoon, the Sun shining, by the Help of your Quadrant place the Instrument parallel to the Horizon; screw up your perpendicular

* See Page 21, Note 4.

Pin in the *Center* 'till the *Shadow* of its *Top* touch any of the *Circles*, it matters not which, as suppose the *outmost* at *F*; let all Things now rest 'till *Afternoon*. [4] And then carefully observe where the *Top* of the *Shadow* toucheth the *same Circle* again, which we will suppose at *G*; thus is your *Observation* finished. [5] Take your *Instrument* down, and with your *Compasses* divide the *Arch FG* into two equal Parts in *H*, and if from *H* you draw a *Line* through the *Center*, it shall be a *true 12 a-clock Hour Line*; and *NH* is the *Declination of the Wall*, which, by applying it to the *Line of Chords*, I find to be 14 Degrees. And when the *Mark*, last found at *H*, falls on the *East Side* of the *Line NS* (as this doth) then is the *Declination of the Wall East*; but when the *Mark* falls on the *West Side*, then the *Declination is West*.

Note, The *Curve*, that the *Top* of the *Pin* describes, is always an *Hyperbola*, whether it be perpendicular, or incline to the *Horizon*; and such are also the *Parallels* of the *Sun's Declination* when put upon a *Dial*.

CHAP. XI. *To make an erect Declining Dial.*

THE *upright* or *erect* *Dial Planes*, already treated of, are such as did *directly* face the *four cardinal* or principal Points of the *Horizon*, viz. *East, West, North* and *South* Points. NOW ALL OTHER *upright* or *erect* *Dial Planes* are said to *decline*, * and their *Declination* is counted from the *North* or *South*, towards *East* and *West*, and those *Planes* are called *South* or *North* *erect Planes declining East* or *West*.

* See Page 21, Note 4.

Plate 7. Fig. 2.

Let it be required to make a Dial in the *Latitude* of 53 Deg. 25 Min. *North*, declining from the *South* to the *West* 21 Deg. 10 Min. viz. for *Liverpool*, *Warrington*, or *Cronton*, in *Lancashire*.

First, *For the Distance of the Substilar Line from the 12 a-clock Hour Line.*

[1] Draw the *Horizontal Line* AB, and from C let fall *perpendicular* the 12 a-clock Hour Line CD, and from the *Line of Chords* take 60 Deg. with your *Compasses*, and set one Foot of your *Compasses* in C, and draw the *Semicircle* ADB. [2] And then draw CD at *right Angles* to AB, for the 12 a-clock Line. [3] Take the *Complement of the Latitude* 36 Deg. 35 Min. from your *Line of Chords*, and set it from D to E, and draw EF *parallel* to AB, so is FE the *Sine* † of the *Arch* DE. This done, [4] take in your *Compasses* the *Plane's Declination* 21 Deg. 10 Min. from your *Line of Chords*, and set it from D to G, and draw CG. [5] Take EF in your *Compasses*, and set it from C to H; draw HI *parallel* to AB. [6] Take HI and set from F to L, and draw CLM; now DM measured on your *Line of Chords* is 15 Deg. 2 Min. the *Distance of the Substilar Line from the 12 a-clock Line.*

Secondly, *For the Stile's Height.*

[1] From the Point H draw the Line HK *parallel* to CD the 12 a-clock Line. [2] Then take

† The *Sine* of an *Arch* is a Line drawn from any Point of the *Circumference* of a Circle to that Line that passes thro' the Center of the said Circle.

Chap. XI. *Of the Declining Dial.* 33

HK in your Compasses, and set it from L to N, and draw CN for the *Top of the Stile*; [3] Then shall MN measured on your *Line of Chords* be 31 Deg. 49 Min. the *height of the Stile*.

Thirdly, *For the Difference of Inclination * of Meridians.*

[1] Set one Foot of your Compasses in M, and take the *nearest distance* to EF. *This Distance* set upon the 12 a-clock *Line* from F to O. [2] Then take the *distance* from O to G, and set it from O to P. [3] Take the *distance* PM in your Compasses, and measure it on your *Line of Chords*, and you will find it to be 25 Deg. 46 Min. the *Inclination of Meridians* sought: This 25 Deg. 46 Min. reduced into Time (by the *Table III.*) is 1 Hour, 43 Min. 4 Seconds, by which I see that the *substilar Line* will fall between the Hours of one and two a-clock in the *Afternoon*.

Lastly, *For the Hour Lines.*

[1] In any convenient Place in the *Substilar Line* (according to the Largeness of your Dial Plane) as at M, draw the Line RS at *right Angles* to the *Substilar Line* CM [2] Set one Foot of your Compasses in M, and take the *nearest distance* to CN the *Stile's height*, [3] One foot resting in M, turn the other to q in the *Substilar Line*, upon q as a *Center*, with the *distance*

* See Plate 7. Fig. 1, in which HI represents the 12 a-clock *Hour Line* in that Place, and NS is the *Line* that is *perpendicular* to the *Plane*; now the *Angle* that is made between these two Lines at I, is what in Dialing is called the *Inclination of Meridians*, and is an *Arch* of the *Equinoctial*, comprehended between the *Meridian* of the *Plane* and the *Meridian* of the *Place*, and shews in what *Longitude* from the *Meridian* of the *Plane* it will become an *Horizontal Dial*.

D

q M,

q M, draw *the Circle* as you see done in the Dial, which represents the *Equinoctial*.

[4] Lay a Ruler from *the Center* at q to D (that is the Place where the *Line RS* cuts the 12 *a-clock Hour Line*) and then the Ruler doth cut the *Equinoctial* in a Point *near O*, where you are to begin to divide it into 24 *equal Parts*, which I have here marked with little *Dots*. [5] Lay a Ruler to the *Center* at q, and to every one of the *equal Divisions* in the *Equinoctial*, and where the Ruler cuts the *Line RS*, make these marks *** *Lastly*, draw Lines from the *Center* of the Dial at C to these marks *** in the *Line RS*, and those are the true *Hour Lines* upon the Dial, to which place the proper Figures to every *Hour*, as you see done in the *Scheme*.

Of the hanging of the Stile.

The *Stile CN* must hang *directly Squarewise* with the *Substilar Line CL*, and this you must try with your *Quadrant*, thus; place *that edge* of your *Quadrant* upon which *the Sights* are, to the *Top of the Stile*, and when the *Tbread* cuts the *Limb* of the *Quadrant* in the *same Degree* with the *Latitude of the Place*, then it is *right* otherwise it is *wrong*.

Note, Now you have finished your Dial, and in so doing, you have in the making of this one made four *Dials*, viz.

	Deg.	Min.
A South Declining East	}	21 10
A South Declining West		
A North Declining East		
A North Declining West		

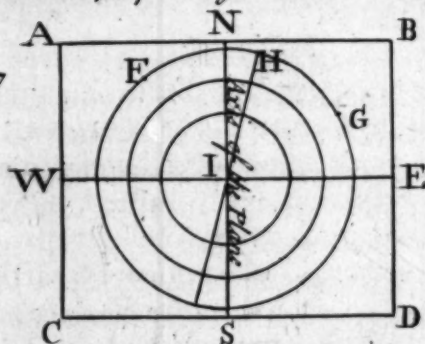
But



The Instrument for finding the Declination of a Wall &c

Plate 7

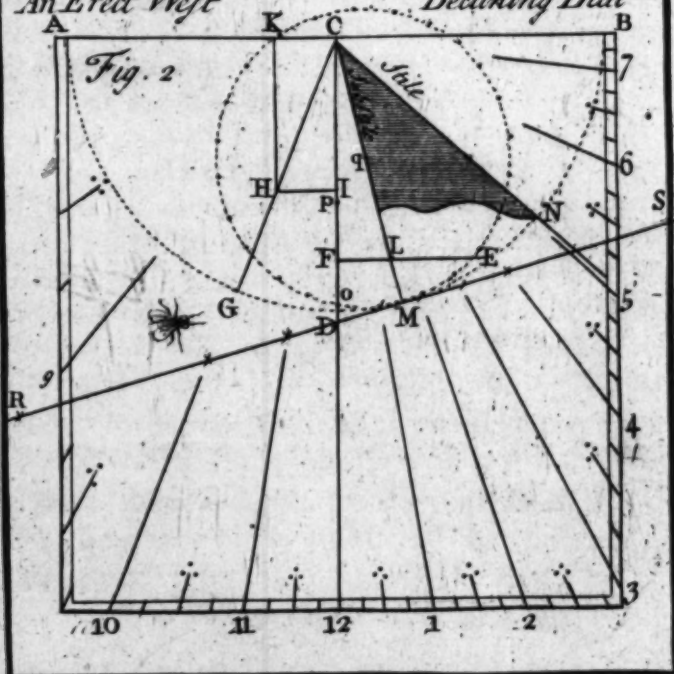
Fig 1



An Erect West

Declining Dial

Fig. 2



But you must change the *Names of the Hours*, viz. 10 into 2, 9 into 3, 8 into 4, &c.† and place the *Stile* on the *contrary Side* of the 12 a-clock *Line* for the *South declining East*, and by turning the *Dial upside downwards*, for the *North Decliners*, so that the *Stile* may point *upwards* to the *North Pole*, and the *Hours* about midnight omitted, as your own Reason will soon direct you.

Here you are to take notice, that if the *Plane* decline 60 *Deg. or more*, then the *Hour Lines* having *Centers* will be so near together, and the *Stile* will then be so near the *Plane*, that one thing will much discommode another, and make it a great difficulty to shew the *true hour* of the *Day* thereby, therefore they ought to be removed far from the *Center*, that they may become wide enough to answer the end of shewing distinctly the *true Hour* of the *Day*.

But still here will arise a Difficulty in dividing the *Circle*, which represents the *Equinoctial*, for there will be required the Difference of the *Inclination of Meridians* of the *Plane* and *Place*; for this Purpose I have added *Table V.* for the *Latitude of London*, shewing the *Stile's height*, *Substile's distance* from the *Meridian*, and difference of *Inclination of Meridians*, which tho' calculated indeed for the *Latitude of London* (viz. 51 *Deg.* 32 *Min.*) yet may serve indifferently

† And here you are to observe that it is not the *Stile* that changes its *Place* or *Position*, but the *Plane itself*; for the *Stile* answering to the *Latitude of the Place*, it remains always steady and the same in all *Declinations*: so that if you conceive a *Plane* declining (as in the *Example* now before us) 21 *Deg.* 10 *Min.* to the *Westward*, the *Subsilar Line* falls betwixt the *Hours* of *One* and *Two* in the *Afternoon*; and supposing the same *Plane* to move to the *Eastward* 21 *Deg.* 10 *Min.* the *Subsilar Line* will then fall betwixt the *Hours* of *Ten* and *Eleven* in the *Morning*. For it is an *infallible Rule*, that if the *Plane* declines *Eastward*, the *Subsilar Line* falls amongst the *Morning Hours*, but if *Westward*, amongst the *Afternoon Hours*.

for most Places in *England*; but he that wants to be more curious and exact, may, by observing the Directions given in the beginning of this Chapter for finding the *three Requisites* (by that means) obtain those *Requisites* for any Place in the known World.

CHAP. XII. To make a Dial upon a Plane when the Pole has but a small Elevation above the Plane.

Plate 8. Fig. 1.

I shall take for an Example a Dial that I made at London, whose Plane declined from the South by the East, northerly 100 Deg. 16 Min. that is 79 Deg. 44 Min. from the North towards the East.

For the Stile's height.

The Stile's height you will find by Construction, as in Chap. X. or by Table V. to be 6 Deg. 22 Min. the Substile's distance from the Meridian, 38 Deg. 1 Min. the Inclination of Meridians, 81 Deg. 56 Min. [1] Let the Square ABCD represent the Plane, because 'tis a North Plane declining Eastward, therefore the Stile must point upwards, and the Center of the Hour Line will be some where below the Plane itself. * And therefore take 60 Deg. from your Line of Chords. Set one Foot of your Compasses at the bottom Corner of the Plane at C, and draw the Qua-

* If the Plane had been 79 Deg. 44 Min. from the South to the East, or West, then the Stile must have pointed downwards towards the South Pole, and the Center of the Dial would have been some where above the Plane itself.

drant EF. [2] Take 38 Deg. 1 Min. from your *Line of Chords*, (the *Substile's* distance from the 12 a-clock *Line*) and set it from F to G, then draw CG continued for the *Substilar Line*. [3] Take 6 Deg. 22 Min. the *Stile's* height from your *Line of Chords*, and set it from G to H, and draw CH for the *Stile*: [4] Now, because the *Stile* has but *small height*, draw an *other Line IK* parallel to the height or top of the *Stile* of the *Dial*, at such convenient distance as in your judgment will best fit the *Dial Plane*, viz. that all the *Hour Lines* may fall thereon, so shall that *Line IK* be the *enlarged Stile* of the *Dial*.

For the Hour Lines.

[5] Now by the *Substilar Line*, and this *enlarged Stile*, the *Hour Lines* may be drawn (at convenient distances) without any regard had to the *Center* of the *Dial*.

And to do that, assume any *two Points* in the *Substilar Line* CG, at some convenient distance from each other, as L and M, and through those *two Points* draw *two streight Lines*, both of them at *right Angles* to the *Substilar Line* CG, as the *Lines* NLO and PMQ. [6] Set one foot of the *Compasses* in L, and take the nearest distance to the *enlarged Stile IK*, and turn that foot from the *Stile* to R; on R as a *Center* with the distance LR draw a *Semicircle*, set one foot of the *Compasses* in M, and take the nearest distance to the *enlarged Stile IK*, and turn that foot from the *Stile* to S; on S, as a *Center*, draw a *Semicircle*.

[7] Take the *Plane's Inclination of Meridians*, 81 Deg. 56 Min. and set from L to T, and from M to V upon the *Semicircles*. † Then

† You must make the *Radius* LT, and MV, severally the *Radius* of a *Line of Chords*, when you set off the *Inclination of Meridians*.

[8] Divide *each Semicircle* into 12 equal Parts, beginning at T and V; lay a Ruler to the Centers R and S *severally*, and to the Marks just now made in the *Semicircles*, and the Ruler will then cut the Lines PMQ and NLO, in the true Places where the *Hour Lines* must be drawn.

Lastly, Lay a Ruler to *those Marks* in the Lines PMQ and NLO, and draw *right Lines* through the *Plane*, and they shall be the *true Hour Lines* required, and will be removed far enough from the *Center*, and that will shew distinctly the *Hour of the Day*.

For the Stile.

The *Stile* must stand at *right Angles* upon the *Substilar Line* IK. And must be placed as near to the widest distance of the *Hour Lines* as possible; because the wider the *Hour Lines* are, the better may the *Hour of the Day* be discovered.

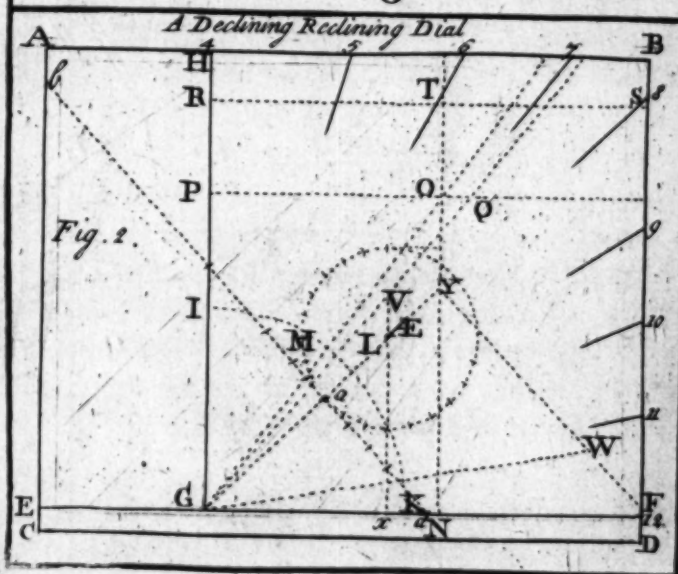
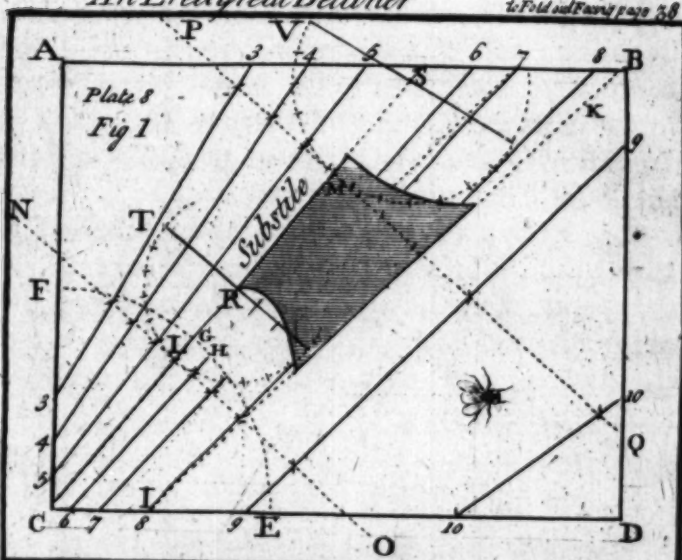
For the Quarters.

The *Quarters* are drawn by dividing *each of the 12 equal Parts* in the *Semicircles* into *four equal Parts more*, and from *those Divisions* draw *Lines*, as has been taught above for drawing the *Hour Lines*, and your *Dial* is finished.

CHAP.

An Erect great Decliner

to Fold and Fasten page 38





CHAP. XIII. To make a declining reclining* Dial.

Plate 3. Fig. 2.

SUCH Planes as do directly face the *South* or *North Points* of the *Horizon*, but do *recline* (or fall backwards) from the *Zenith* (like the *Roof* of a House) towards the *South* or *North*, are called *South* or *North Direct Planes*, *reclining* so many *Degrees* as the *Reclination* is; and the Number of *Degrees* that the Plane *reclines*, may be found by applying the *Edge* of your *Quadrant*, in which the *Sights* are placed to the *Plane*, and the *Thread* will cut the *Limb* in the Number of *Degrees* that the Plane *reclines*, which being a Thing so plain, I need not give any Example.

And of *reclining Planes* there are *six Varieties*, *three* of *South*, and *three* of *North Recliners*, all which may be reduced to *new Latitudes*, wherein they will become *Horizontal Planes*, and consequently *Dials* may be made as has been taught, Chap. IV. where I have shewn how to draw *four Lines* upon an *Horizontal Plane*.

First of Direct South Recliners.

First Variety: Let there be a *direct South Plane* in the *Latitude* of *Cambridge*, which is *52 Deg. 12 Min.* which *reclines* from the *Zenith* thereof *26 Degrees*; in what *Latitude* will that be an *Horizontal Plane*?

* Those *Dial Planes* that *lean* from you when you stand before them, are called *reclining Planes*, because they *recline* from the *Zenith*.

D 4

Now,

46 *Of direct North and South* Chap. XIII.

Now, because the *Reclination* is less than the *Complement of the Latitude* 37 Deg. 48 Min. *Subtract* the *Plane's Reclination* 26 Deg. from the *Complement of the Latitude* 37 Deg. 48 Min. and the *Remainder* 11 Deg. 48 Min. is the *new Latitude* in which it becomes an *Horizontal Plane*.

The Operation.

	Deg.	Min.
The <i>Complement</i> of the <i>Latitude</i> at <i>Cambridge</i> is	—	37 48
The <i>Plane's Reclination</i> there (which <i>subtract</i>) is	—	26 00
The <i>new Latitude</i> is	—	11 48

So that an *Horizontal Dial* made for the *Latitude* of 11 Deg. 48 Min. shall be a *South Recliner* 26 Degrees in the *Latitude* of *Cambridge*.

Second Variety. If the *Reclination* of the *Plane* be equal to the *Complement of the Latitude* of the *Place*, the *new Latitude* is nothing, that is, neither *Pole* has any *Elevation* above such a *Plane*, and the *Hour Lines* are all parallel, and the *Stile* is likewise parallel to the *Plane* itself; and therefore, a *Dial* for such a *Plane* must be made in all *Respects*, as has been shewn *Chap. IX. Plate 6.*

So that admit at *Lincoln*, where the *Latitude* is 53 Deg. 13 Min. a *South Plane* reclines from the *Zenith* 36 Deg. 47 Min. (which is equal to the *Complement of the Latitude* of that City) I say, it becomes an *Horizontal Dial* under the *Equinoctial*, as appears by the *Operation*.

The Operation.

	Deg.	Min.
The <i>Complement</i> of the <i>Latitude</i> at <i>Lincoln</i> is	—	36 47
The <i>Plane's Reclination</i> there (which <i>subtract</i>) is	—	36 47
So you see the <i>new Latitude</i> is	—	00 00

In *Plate 6*, you have the *Dial* that is for this Purpose.

Chap. XIII. Declining Reclining Diab. 41

Third Variety. If the Reclination of the Plane exceeds the Complement of the Latitude of the Place, then subtract the Complement of the Latitude from the Plane's Reclination, and the Remainder is the new Latitude, where it will become an Horizontal Plane.

Example.

Suppose at Norwich, whose Latitude is 52 Deg. 42 Min. a direct South Plane reclining 56 Deg. from the Zenith, where will that be an Horizontal Dial?

The Operation.

	Deg.	Min.
The Plane's Reclination	—	—
Complement of the Latitude of Norwich (which subtract)	—	37 18
The New Latitude is	—	18 42

So that an Horizontal Dial made for the Latitude of 18 Deg. 42 Min. will be a direct South reclining Dial from the Zenith of Norwich 56 Deg.

Secondly, Of Direct NORTH Recliners.

First Variety. If the Reclination be less than the Complement of the Latitude of the Place, add them together, and that is the new Latitude where such Recliner will become an Horizontal Plane.

Example.

Suppose at Newcastle upon Tyne, whose Latitude is 55 Deg. 1 Min. a direct North Plane should recline from the Zenith 29 Deg. how must the Hour Lines be drawn thereon?

To

To the *Complement of the Latitude* of *Newcastle upon Tyne*, 34 Deg. 49 Min. add the *Plane's Reclination* 29 Deg. and their *Sum* is 63 Deg. 49 Min. and that is the *new Latitude*, for which Place make an *Horizontal Dial*, as has been before taught, and that will be a *North reclining Dial*, at the Place above-mentioned.

The Operation.

	Deg.	Min.
The <i>Complement</i> of the Latitude at <i>Newcastle upon Tyne</i> is	—	34 49
The <i>Plane's Reclination</i> there (which add) is	—	29 00
		—
The <i>new Latitude</i>	—	63 49

Second Variety. If the *direct North Plane* *recline* equal to the *Latitude of the Place*, add it to the *Complement of the Latitude*, and that *Sum* will always be 90 Deg. so that under the *Pole* it becomes an *Horizontal Dial*; make a Dial as has been taught in Chap. III. Plate 3. Fig. 1. by dividing a Circle into 24 equal Parts, and fixing a Wire perpendicular in the *Center*, and it is done.

Example.

Suppose at *Wrexham* in *Denbighshire*, whose Latitude is 53 Deg. 2 Min. a *direct North Plane* *reclines* 53 Deg. 2 Min. I desire to know where this will become an *Horizontal Plane*?

The Operation.

	Deg.	Min.
The <i>Complement</i> of the Latitude at <i>Wrexham</i> is	—	36 58
The <i>Plane's Reclination</i> there (which add) is	—	53 02
		—
The <i>new Latitude</i> is	—	90 00

Lastly,

Lastly, If the Plane's *Reclination* exceed the *Complement of the Latitude of the Place*, add them together, and *that Sum* is the *new Latitude* where such a Plane will become an *Horizontal Plane*.

But note, if the *Sum* exceed 90 *Deg.* take the *Complement* thereof to a *Semicircle*, or 180 *Deg.* and the *Remainder* is the *new Latitude*, where such a *Reclining Plane* will become *Horizontal*.

Example.

Suppose at *Shrewsbury*, whose *Latitude* is 52 *Deg.* 42 *Min.* a *direct North Plane* *reclines* from the *Zenith* 60 *Deg.* where will it become an *Horizontal Plane*?

To the *Complement of the Latitude of the Place* 37 *Deg.* 18 *Min.* add the Plane's *Reclination* 60 *Deg.* and their *Sum* is 97 *Deg.* 18 *Min.* whose *Complement* to 180 *Deg.* is 82 *Deg.* 42 *Min.* in which *Latitude* such a Plane at *Shrewsbury* will become *Horizontal*; therefore draw *Hour Lines* thereon, as you have been taught in making the *Horizontal Dial*, and they will be the true *Hour Lines* for that Plane and Place, as just now mentioned.

The Operation.

	Deg.	Min.
The <i>Complement</i> of <i>Latitude</i> at <i>Shrewsbury</i> is	—	37 18
The Plane's <i>Reclination</i> there (which add) is	—	60 00
The <i>Sum</i> (which is to be <i>subtracted</i> from the <i>Semicircle</i>)	—	97 18
A <i>Semicircle</i> is (180 <i>Degrees</i>)	—	180 00
The <i>Sum</i> as above to be <i>subtracted</i>	—	97 18
The <i>new Latitude</i>	—	82 42

Note, That in making of any of these *North* or *South reclining Dials*, you have also made (at the same Time) a *direct North* or *South reclining Dial* from the *Zenith*, 26 *Deg.*

44 *Of East or West Reclining Dials. Chap. XIV.*

As in the first Variety for Cambridge, you have made also a North Dial inclining to the Horizon 26 Deg. either by drawing of the Hour Lines and Style through the Center, or by turning the reclining Dial about, upon the Hour Line of Six; and then as the North Pole is raised or elevated upon the South Recliner, so much will the South Pole be raised or elevated above the North Incliner.

CHAP. XIV. *To make an East or West Reclining* Dial.*

AS all North and South reclining Dial-Planes were reduced to new Latitudes, wherein they would become Horizontal Planes; and thereby made by the Directions given in Chap. IV. so all DIRECT East or West Reclining Dial Planes in any Latitude, may be reduced to erect or upright DECLINING Planes in another Latitude, and therefore may be made by the Directions in Chap. XI. of this Treatise; yet I shall here shew, for the young Tyro's Improvement, how they may be done mechanically, without any such Alteration. But first, to reduce them to new Latitudes,

* As in upright or erect Dial Planes there were two Sorts of Varieties, viz. Erect direct and erect Declining; so there are two Sorts of Varieties of Reclining Dial Planes likewise; for such Reclining Planes as do directly face either the true East, West, North, or South Points of the Heavens are called DIRECT Reclining Planes.

Again, those Reclining Planes which do not directly face the said Cardinal Points, but deviate therefrom, i. e. face some other Points situate between them, as South-East, North-West, North-East, are called DECLINING Reclining Planes, and the manner of drawing the Hour Lines upon these Direct and Declining Reclining Planes, affords a much greater Variety than there was in the erect or upright Planes. See Page 20.

The

The Rule.

The Complement of the known Latitude, or Latitude you are in, is always the new Latitude, and the Complement of the Reclination* is always the Declination in that new Latitude, in which it will become an erect declining Plane.

And before I proceed any further it is proper to inform you how you shall know whether the North or South Pole is elevated above any given Plane.

[1] All Horizontal Planes in North Latitude have the North Pole elevated; but all Horizontal Planes in the South Latitude have the South Pole elevated.

[2] Upon all erect Planes whether direct or declining, if it face the South, the South Pole is elevated; but if it face the North, the North Pole is elevated, as you may the better perceive by viewing the erect direct North and South Dials in Plate II.

[3] Upon all direct East and West Planes (let them recline ever so far) the North Pole is elevated; but on their opposite Incliners the South Pole.

[4] Over all North reclining Planes, whether direct or declining, the North Pole is elevated; and over the opposite Incliners the South Pole.

Lastly, Over all South reclining direct or declining, if the Plane pass between the Zenith and the Pole, the South Pole is elevated, as in the North Pole on their opposite Incliners, and if the Plane lie between

* The Reclination of a Plane is the Quantity of Degrees which any Plane, on which a Dial is supposed to be drawn, lies or falls back from the truly erect or upright Plane.

the

46 *Of East or West Reclining Dials.* Chap. XIV.
the Pole and the Horizon, the North Pole is elevated;
but the South over their opposite Incliners.

Now let it be required to make an *East Dial* for
Worcester, to recline 40 Degrees.

According to the former Method of reducing it to
new Latitudes, it will be an erect Dial in Latitude
37 Deg. 47 Min. (that being the Complement of the
Latitude of Worcester) declining from the South East-
ward 50 Degrees, that being the Complement
of the Plane's Reclination. So that if by the Direc-
tions in the XIth Chapter, you make an erect Dial
for 37 Deg. 47 Min. North Latitude, declining 50
Deg. South East, it will be an East Recliner 40 Deg.
from the Zenith, in the Latitude of 52 Deg. 13 Min.
However I shall here shew how to do it mechanically.

First, You must consider, that the East and West
RECLINERS have their Center near the Bottom
of the Plane, but the INCLINERS of both sorts
have their Centers near the Top: And the East
INCLINER and West RECLINER must have their
Centers towards the right Hand; but the East
RECLINER and West INCLINER have their Cen-
ters towards the left Hand.

These Things being well understood, I shall now
proceed to practice.

Having made choice of your Plane, as suppose
ABCD. Plate 8. Fig. 2.

For the Substilar Line and Stile's height.

According to the foregoing Directions, I observe
that the Center of this Dial must be at the Bottom
towards the left Hand: therefore [1] at the Bottom
of the Plane, draw the Line EF for the 12 a-clock
Line,

Chap. XIV. Of East or West Reclining Dials. 47

Line, in which make choice of some convenient Place, as at G; [2] chuse G for the Center of the Dial, and from G draw GH at right Angles to EF. [3] Then with one foot of the Compasses in G, describe the Quadrant IK, and by the Help of your Line of Chords, set off the Plane's Reclination 40 Deg. from I to L, and draw the Line GL as long as you can, [4] Also set off from I to M the Complement of the Latitude of the Place 37 Deg. 47 Min. and draw the Line GM as long as you can: [5] then in any Point at Pleasure in the 12 a-clock Line EF, chuse a Point as N, and from that Point draw a Line parallel to GH, as NO; and through the Point where it cuts the Line GM, draw PO parallel to EF; [6] take GQ in your Compasses, and set it from G to R, and draw RS parallel to the Meridian EF, and it will cut NO, in T; [7] set the Distance PQ from G to V, and draw VX parallel to TN; [8] take in your Compasses GX, and set it from T to Y, and draw GY for the Substile; [9] from Y erect the perpendicular YW (take VX in your Compasses, and set it from Y to W) and draw GW for the Stile: The Triangle GYW, representing the Stile of your Dial, which being erected perpendicular to the Plane, upon the Substile GY, shall give the Hour by the Shadow of its upper edge.

For the Hour Lines.

[1] Chuse a Point at Pleasure in the Substile GY, as at a; through that at right Angles thereto, draw the Line ba, as long as you can; set one foot of the Compasses in a, viz. the Point where the Line b a cuts the Substile, and take the nearest distance to the Stile's height; let one foot rest in a, and turn the other to Æ in the Substile, and on Æ as a Center describe

48 Of East or West Reclining Dials. Chap. XIV.

scribe the *Semicircle* (or a whole *Circle*, if you please).
 [2.] Lay a Ruler to the *Center* of the *Circle* at *Æ*,
 and to *d*, that is, where the *Line b a* cuts the 12 a-
 clock *Line* *GF*, and where the Ruler cuts the *Circle*,
 there you are to begin to divide it into 24 equal Parts:
 a Ruler laid to *Æ*, and to the equal Parts in the *Cir-
 cle*, will cut the *Line b a* into unequal Parts, where
 make Marks*** Lastly, A Ruler laid to the *Center*
 of the Dial at *G*, and to those Marks*** in the *Line*
b a, will be the true *Hour Lines* required.

The *Line* *GF* being the 12 a-clock *Line*, you must
 place 12 at the end, as you see in the *Figure*, and there st
 11. 10. 9. 8. 7. 6. and then your Dial is finished.

N.B. In drawing this Dial, you have made three
 more; for if it is turned upside down, then it is a *West*
Dial inclining 40 Degrees, with this Alteration only,
 that where 1 now stands you must place 1, and 2 where
 10 is, &c. and consequently the *Substile* will then be as
 much on the right Hand, as it is now on the left.

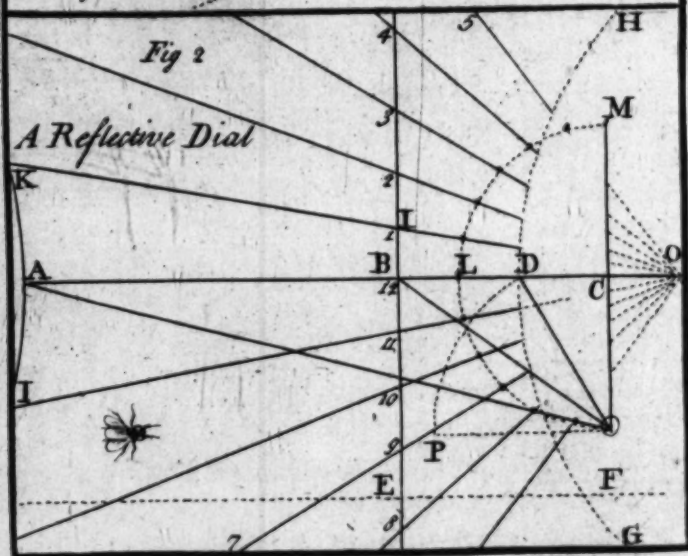
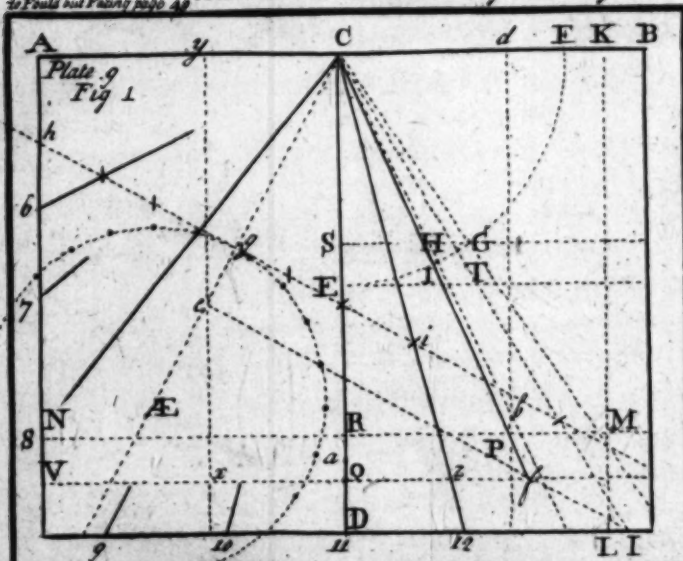
If it were drawn upon oiled Paper, the back-side
 would be a *West* Dial, reclining 40 Deg. only the
 Figures 12. 10. 9. &c. must be 1. 2. 3. &c.

Lastly, If the 12 a-clock *Line* *GF* be turned
 upwards, the back-side will be an *East* Dial inclining
 40 Deg. and the Figures must remain just as they
 are; only the *Substile* must be as far to the left Hand
 of the perpendicular *GH*, as it is now on the right.

CHAP.



to Gould and Facing page 42 **A North or South Declining Inclining Dial**



CHAP. XV. To make a North or South Declining* Reclining or Inclining Dial.

Plate 9. Fig. 1.

THESE Dial Planes cannot be reduced to new Latitudes without the help of Trigonometry, therefore I shall proceed Mechanically.

Take for an Example a Plane at Edinburgh declining from the South to the East 30 Deg. and reclining from the Zenith 25 Deg.

First for the Stile.

[1] Draw the Horizontal Line AB; [2] make choice of any convenient Place in the Line AB, as C, for a Center, and draw CD. [3] With your Line of Chords of 60 Deg. draw the Quadrant FF. [4] Take the Complement of the Latitude of Edinburgh 34 Deg. 3 Min. from your Line of Chords, and set it from E, to G, and draw the Line CG as long as you can. [5] Take the Plane's Declination 30 Deg. from your Line of Chords, and set it from E to H, and draw the Line CH, as long as you can. [6] Take the Inclination of the Plane 25 Deg. from your Line of Chords, and set it from E to I, and draw the Line CI as long as you can. [7] Make choice of a Point in the Line AB as K, and draw KL parallel to CD, and it cuts the Line CG (the Complement of the Latitude) in M, and thro' that crossing draw MN parallel to AB,

* Those Dial Planes that lean towards you when you stand before them are called Inclining, and those that lean from you are called Reclining and Declining. Reclining or Inclining Dials, are those whose Planes neither face directly any of the four Cardinal Points; nor are they either perpendicular or parallel to the Horizon.

E

and

50 *Of North and South Reclining Dials. Chap. XV.*
 and it cuts the *Line of Inclination* CI in P. [8] Take CP, and set it from C to Q, draw QV *parallel* to AB. [9] Take RP in your Compasses, and set it from C to S, and draw SH *parallel* to AB, to cut the *Line of Declination* CH in H. [10] Take CK in your Compasses, and set it upon the *Line of Declination* from C to T, and draw ET *parallel* to AB. [11] Take ET in your Compasses, and set it from Q to X, and draw XY *parallel* to CD. [12] Now take in your Compasses the distance SH (that is from CD to the *Line of Declination*) and set it from Q to Z, and draw CZ for the *Meridian Line*, or *Hour Line* of 12. [13] Take in your Compasses the distance CS, place one Foot in E, and make a Mark where the other Foot falls at a. [14] Take Ca, and set it from C to b upon the *Line of Inclination*, and draw bd *parallel* to CD. [15] Take in your Compasses Cd, carry that extent, and set one Foot of the Compasses in X, and the other will give e, draw Ce for the *Substile*, from e erect the *Perpendicular* ef. [16] Take bd, and set it from e, to f and draw the Line Cf for the *Stile*, so shall the Triangle Cef be the *Stile* to be erected *Perpendicular* to the Line Ce the *Substile*. The Side Cf, being *parallel* to the *Axis* of the World, and by its *Shadow* is determined the *Hour of the Day*.

For the Hour Lines.

[1] Chuse a Point in the *Substile* Ce, as g, thro' which Point, and at *right Angles* to the *Substile*, draw the Line gb. [2] Set one Foot of the Compasses in g, and take the *nearest Distance* to the Line Cf, and turn that Foot about to Æ; upon Æ with the Distance Æg, draw the *Equinoctial Circle*, or so much of it as will suffice to bring the *Hour Lines* up-

on

Ch. XV. Of North & South Reclining Dials. 51

on the Plane that you have Occasion for. [3] Lay a Ruler to the Center at Æ , and to i ; that is, where the Line bi cuts the Meridian or 12 a-clock Line, and there begin to divide the Equinoctial Circle into 24 equal Parts; a Ruler laid to Æ and to those equal Parts, will divide the Line bi unequally, and give the Places thro' which the Hour Lines must pass: Lastly, Lines drawn from the Center of the Dial at C , thro' those Marks in the Line bi , shall be the true Hour Lines of that Dial; which Number as you see done in the Figure.

Note, You may draw your Dial with Charcoal or Black-lead (that is, the Preparative Work) that it may be taken out when you have put on the Hour Lines, so that nothing may appear but what is really useful.

All other Declining Reclining Dials are made by the same Directions that are given in this above, only by changing the Figures, &c.

As Secondly, The Incliner, Declining from the South Westward, is made by the same Directions, only the Quadrant must be drawn on the other side towards A , which may be best conceived by supposing this Dial to be drawn on oiled Paper; and looking thro' the Paper, that which on the right side of the Paper was an Inclining Dial, declining from the South Eastward, will be an Inclining Dial, declining from the South Westward.

Thirdly, A North Declining East Recliner is the same with a South Decliner East, Reclining from the Zenith, only the Horizontal Line must be at the Bottom of the Dial; and also the Center of the Quadrant (which is the Center of the Hour Lines) must be above the Line AB , and towards the left Hand,

and may be represented by a *South Declining East Recliner*, turned *Bottom upwards*, with the *same side* towards you as before.

Fourthly, A *North Declining West Recliner* is the same with a *South Declining West Incliner*, only (as before) the *Horizontal Line AB*, must be at the *Bottom* together with the *Center* of the Dial, and the *Quadrant* must be *above the Line*, and towards the *right Hand*, and may be represented by the Dial already described, if imagined to be done upon *oiled Paper*, and seen thro', being turned *Bottom upwards*.

N. B. *The Hours on the North Dials must be numbered the contrary way to those of the South Dials.*

CHAP. XVI. *To make a Reflective* Dial.*

Plate 9. Fig. 2.

THIS Dial will shew the true Hour of the Day by *Reflection* on a *Cieling*, where the *direct Beams* of the Sun can never come, and it will represent the *Sun's Motion*, as truly and regularly *within the House*, as his natural Motion is *without*, provided the *Window* open to the *Southward*, or so that the Sun might shine in or near it.

These sorts of Dials are grounded upon this Principle in *Opticks*, viz. *that the Angle of INCIDENCE is equal to the Angle of REFLECTION: that is, whatever height the Sun be at any Time, the same height has the reflected Spot upon the Cieling.*

Reflective or reflecting Dials are made by a little piece of Looking-Glass duly placed, which reflect the *Sun's Rays* to the top of a *Cieling* where the Dial is drawn: N. B. The Piece of Glass should be as thin as it can well be ground.

This

This being understood, it is easy to draw *Hour Lines* upon the *Cieling* of a Room, or upon any other Place though never so Irregular; and that the *Hour* by the help of a *Piece* of a *Looking-Glass* fixt *Horizontally* in a *Window*, or some other convenient Place for that Purpose, may be truly known.

To place the Glass.

[1] Having then made choice of a *Window* towards the *South*, that so you may have as much of the *Morning* and *Afternoon* Sun as possible, take special care to fix your Glass *Horizontal*, otherwise your Work will all be spoiled.

N. B. All *Great Circles*, as *Equinoctial* and *Hour Circles*, are *streight Lines*, and the *lesser Circles*, as *Tropicks* and other *Parallels of the Sun's Declination*, are *Conick Sections*: and that this Dial (when drawn) is no other than a *Horizontal Dial* for the same *Latitude inverted*, Plate 9. Fig. 2.

To draw the 12 a-clock Hour Line.

[2] Having then placed a *Piece* of a *Looking-Glass* about the bigness of a *Sixpence*, marked thus $\odot$ in the *Figure*. Over this Glass hang a *Plumb Line* at 12 a-clock, this String will cast a true *Meridian Line* (i.e. it is the true 12 a-clock *Hour Line*) upon the *Floor*.

Or if you think that way too difficult, you may find a 12 a-clock Line as I have taught in Chap. IV. page 19 and 20. This being done, the 12 a-clock Line on the *Floor*, is to be transfer'd to the *Cieling*, which may be performed by the Help of two *Plumb Lines*, one held over the Glass $\odot$, and the other held over

* A *Cone* doth somewhat resemble a *Sugar Loaf*, and being cut any where slope-wise is called a *Conic Section*.

the other end of the 12 a-clock Line at A, at the other end of the Room; by this means you will have two points on the Cieling, just over your 12 a-clock Line on the Floor, to which two Points on the Cieling stretch a Line blacked with Lamb-Black and Oil, and holding it fast at both Ends, (as two Sawyers or Carpenters generally do a CHALKED LINE) striketh the black 12 a-clock Line on the Cieling, represented by AC.

To draw the Equinoctial.

[3] Make the *Angle BOP*, equal to the *Complement of the Latitude of the Place*, as suppose at Ormskirk 36 Deg. 30 Min. which you must do by a String, held one end to the Glass $\odot$, and the other to the Cieling represented by $B\odot$, and applying the Edge of your Quadrant, till you find the String and Plumbet, cut the Limb at 36 Deg. 30 Min. thro' that Point of the 12 a-clock Line; at B the Equinoctial Circle must pass, which draw at right Angles to the 12 a-clock Line AD, and it is a streight Line as you see in the Figure.

To draw the Tropick of Cancer.

[4] Then because the Sun's greatest height at 12 at Noon, at Ormskirk is 59 Deg. 59 Min. make the *Angle DOP* equal thereto by help of your Quadrant and String as before: so is the Point D, the Point in the 12 a-clock Line, where the Tropick of Cancer must pass, which, because it is a lesser Circle of the Sphere, it is not a streight Line but a Curve which must be drawn by help of Table VI; (that is by having the Sun's height at every Hour the 21st of June for the Latitude of your Place;) so with an even hand, you may draw the Tropick of Cancer GDH.

To

To draw the Tropic of Capricorn.

[5] Because the Sun's *least height at 12 at Noon* at Ormskirk is 13 Deg. 1 Min. make the Angle $A \odot P$ equal thereto, by help of your *Quadrant and String*, so shall A be the Point in the 12 a-clock Hour Line on the *Cieling* where the *Tropick of Capricorn* must pass, and must be drawn by the *Table of the Sun's Altitude at every Hour*, upon the 21st of *December* as above directed, so that $\odot D$ represents the *reflected Ray* on the *longest Day*; $\odot B$, when he is in the *Equinoctial*, that is *twice a Year*, viz. on *March 22d*, and *September 21st*, and $\odot A$ represents the *reflected Ray* on the *shortest Day*.

To draw the Hour Lines.

[6] With any convenient opening of your *Compasses*, draw the *Semicircle* $\odot L M$, and divide it into 12 equal Parts, because 15 Deg. in the *Equinoctial* is equal to one Hour in Time, as by *Table III*.

Hence, because the *Center of the Dial* doth not fall in the room, but out of it in the open Air at O, for which Reason (before the *Hour Lines* can be drawn) you must find the Angle that each *Hour Line* makes with the 12 a-clock Hour Line, their *Complements* are what they make with the *Equinoctial*; this is easily done by *Calculation*, but because I have throughout this *Treatise* laid that Method aside, and kept strictly to a *Mechanick Method*, your best Way will now be to draw an *Horizontal Dial* for the *Latitude of Ormskirk*, which is 53 Deg. 30 Min. as has been taught in Chap. IV. and with your *Compasses* and *Line of Chords* measure the Angles that the *Hour Lines* make with the *Meridian*, and set them down as followeth.

Hour.		Meridian.	Angles with the Equinoct.	Angles with the
12	0	0	0	0
1	11	2	10	77
2	10	24	54	65
3	9	38	47	51
4	8	54	19	35
5	7	71	34	18
6	6	90	00	00

Then with your *Quadrant* lay it to the 12 a-clock Hour Line, and make *Angles* there upon the *Cieling* equal to those in the second Column; or else you may lay it to the *Equinoctial Line* on the *Cieling*, and make the *Angles* of every Hour equal to those in the third Column of this

Table, and by the help of your *blacked String*, as before directed, draw the *Hour Lines* upon the *Cieling*, which shall be the true *Hour Lines* required.

Another Way to draw the Hour Lines.

Or if you think this way too tedious, when you have your *Horizontal Dial* fitted to your *Latitude*, place the *Center* of your *Horizontal Dial* in the *Center* of the *Glass*, and fix a *Thread* in the *Center* of the *Dial*; lay the *Thread* streight over every Hour of your *Horizontal Dial*, fasten it at the other side of the *Room*; and so transfer them to the *Cieling*, as was shewn in drawing the 12 a-clock Line from the *Floor* by help of the *Plumb Lines*; thus have I given you two Methods by which you may draw the *Hour Lines* on the *Cieling*, which I leave to the judicious *Practitioner* to make use of which he pleases.

To make a Table for drawing the Hour Lines.

The framing of a *Table* of the *Angles* that the *Hour Lines* make with the 12 a-clock Hour Line and *Equinoctial*, is made after this manner, viz. Suppose I would measure the Angle DOP in Plate 9. Fig. 2. Take your *Compasses* and extend on the *Line* of *Chords* from the End of the *Line* at O to 60

Deg.

Deg. with that extent set one foot in $\odot$, and draw the Arch $P D$; take the said Arch $P D$ in your Compasses, and apply it to your *Line of Chords*, and you will find it to contain 59 Deg. 59 Min. and such is the Angle $D \odot P$. And after the same manner is any other Angle measured.

CHAP. XVII. To make a Refracted * Dial.

FOR this purpose you must have in readiness an *Horizontal Dial* for the *Latitude of your Place*, and then stick up a *Pin* or *Wire*, or assign any Point in any hollow *Bowl*, or *Dish*, to shew the *Hour*, and make that the *Center* of your *Horizontal Dial*; then fix upon any Place on the *Edges* of the *Bowl*, or *Dish*, for the 12 a-clock *Hour Line*, and transfer the rest of the *Hour Lines* from the *Horizontal Dial* to the *Edge* of the *Bowl*; and taking away the *Horizontal Dial*, hold up a *String* from the *End* of the said *Pin* fastened thereto, over the 12 a-clock *Hour Line* equal to the *Latitude* of your *Habitation*; and this is done by applying the *Edge* of your *Quadrant* to the *String*, till it cuts the *Latitude of the Place* upon the *Limb* thereof.

Then with a *Candle*, by bringing the *Thread* to cast a *Shadow* on any *Hour Point*, just before marked upon the *Edge* of the *Bowl*, that *Shade* in the *Bowl* is the Place to which the *true Hour Line* must be drawn; and if the *Bowl* be full of *Water*, or any other *Liquor*, when the *Hour Lines* are drawn, it

* *Refracted Dials* are such as shew the *true Hour* only by means of some refracting transparent Fluid, such as *Water*, &c.

will

will never shew the *true Hour* by the Shadow of the Top of the Pin, but when the Bowl is filled again with the same Liquor.

For more particular Satisfaction, see my *Astronomy* under the Word *Refraction*, Vol. I. Page 38.

CHAP. XVIII. To make a Globe Dial.

Plate 10. Fig. 1.

THIS Dial is drawn upon a *solid Ball* or *Globe*, and shews the *Hour* of the Day without a *Stile* or *Gnomon*.

The manner of turning round Balls, is well known to Workmen; but if a large *Stone Ball* is to be made, that cannot be turned because of its *Weight*.

You must therefore in the first Place form it *globular* with a *Chissel*; and then take a wooden or brass *Semicircle* (as in Fig. 2.) of the same Diameter, as you design your *Ball* (the bigger the better;) this being done, turn the *Semicircle* about the *Ball*, and take away all the *Superfluities* with a *Rasp*, until the *Semicircle* every where, and every way, just touches the *Superficies* thereof; afterwards make it smooth with a *Pumice Stone*, or *Sea Dog's Fish Skin*.

For the Circles of the Sphere.

The *Globe* being thus finished, and set in your Garden upon a *Pedestal*, as Fig. 1, proceed to draw thereon the *Circles of the Sphere* (by help of a Pair of *spheric Compasses*, or a *Semicircle* that just fits the *Globe*) as AB the *Horizon* ZN the *prime Vertical*, so shall Z be your *Zenith*, and N your *Nadir*.

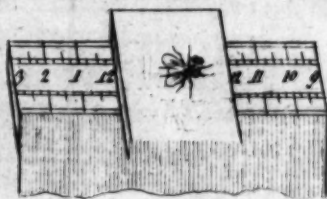
Draw



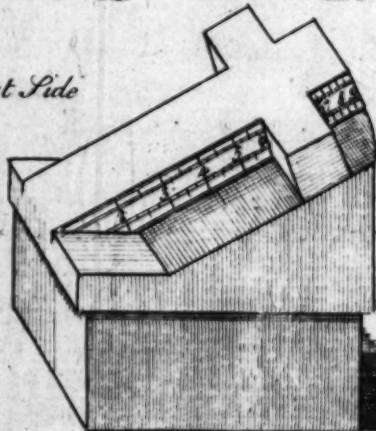
The Cross Dial viewed in three different positions

South End

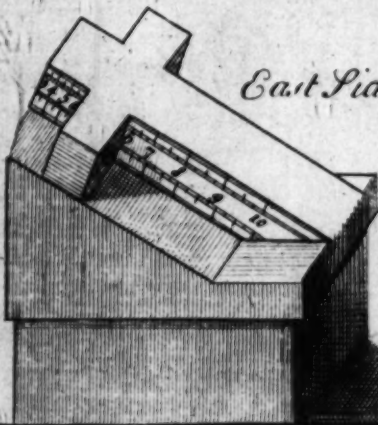
Plate X



West Side



East Side



to Fold out facing page 59



Plate 10

Fig. I.

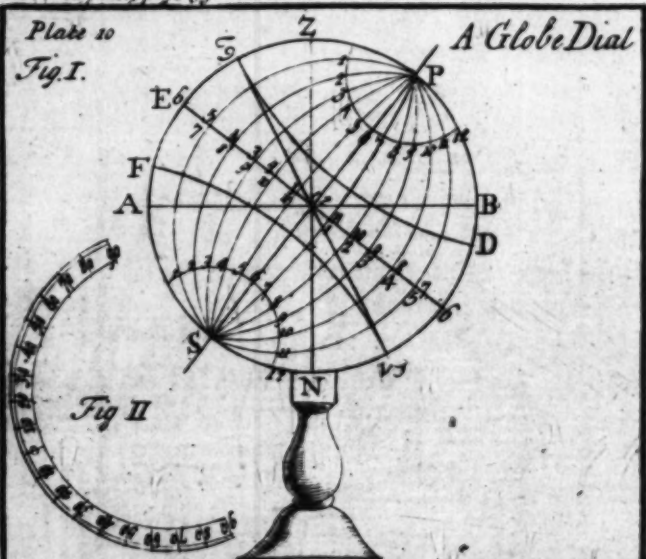
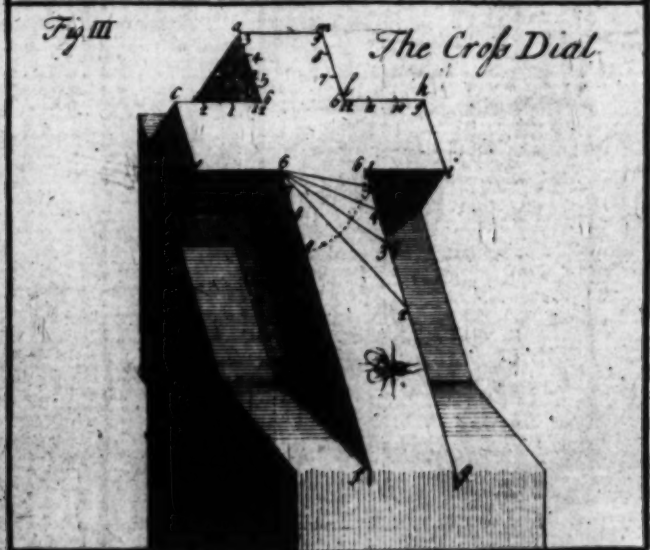


Fig III

The Cross Dial



Draw PS for the *Earth's Axis* to any *Latitude*, as suppose that of *Dublin* 53 Deg. 16 Min. so shall P be the *North Pole*, and S the *South Pole* of the *World*. Make Z Æ equal to BP, and draw Æ æ for the *Equinoctial*, which divide into 24 equal *Parts*, and draw the *Hour Circles* or *Meridians* all meeting in the *Poles* of the *World*.

Your *Semicircle* being divided into 180 Deg. and numbered as you see in Fig. 2. mark 23 Deg. 29 Min. from the *Equinoctial* at Æ to ∞ and F, and draw ∞ D for the *Tropic of Cancer*; and F ∞ for the *Tropic of Capricorn*; also from the *Poles* at P and S mark (by help of your *Semicircle*) 23 Deg. 29 Min. and draw the two *Polar Circles*; 12, 12. Lastly, Draw ∞ ∞ for the *Ecliptic*, and thereon place the 12 *Signs of the Zodiac*, beginning at the *Equinoctial*, where the *Ecliptic* cuts it with γ ; at 30 Degrees further, place δ , at 30 Degrees from that, π , at 30 Degrees more, put ∞ , which will be where the *Ecliptic* cuts the *Tropic of Cancer*, and so on, at every 30 Degrees in the *Ecliptic*, place the *Signs* in order thus, δ π ∞ γ ∞ δ . I have omitted them in the Figure to avoid Confusion.

For the placing of the Hours.

The *Hours* must be numbered in the *Equinoctial*, placing 12 at the *East* and *West Points* of the *Horizon*, and 6 upon the *Meridian*. Then because one half of the *Globe* (nearly) is illuminated when the *Sun* shines, and the other half remains in *Darkness*, and so the *Extremity* of the *Light* shews the *Hour* in two opposite Places.

If moreover the *different Countries* on the *Earth's Superficies*, as likewise the *principal Cities* were laid down upon the *Globe*, according to their true *Latitudes*

tudes and Longitudes, you may discover any Moment the Sun shines upon the same, by the *illuminated Part* thereof, what Places on the Earth are *enlightened*, and what Places are in *Darkness*. The *Extremity of the Shadow* shews likewise what Places the Sun is *Rising* or *Setting* at; and what Places have long Days; these with many more *curious Problems* are seen at one View, too many to be enumerated in this Place.

This Dial is the *most natural* of all others, because it resembles *the Earth itself*, and the *exact manner of the Sun's shining* thereon.

Note, You may draw as many *Parallels of Declination* upon it as you please, by the *Table of the Sun's Declination*. See Table I.

Also if two Wires be put in, one at P and another at S, and 12 at the *Meridian*, and the *Hours* numbered as you see, that Wire at P, will give the Hour in the *Summer*, and that at S the Hour in the *Winter*.

CHAP. XIX. To make a Cross Dial, a Star Dial, and a Window Dial.

Plate 10. Fig. 3.

A Cross Dial is that which shews the *true Hour* of the Day without a *Stile*, by the *Shadow of one Part* of the Dial itself, appearing upon *another Part thereof*.

There is one of this sort of Dials near the *South-West Corner of Middle Moorfields, London*.

For

* The *Inscription* upon this Dial being cut in *Iron*, and exposed to the *Weather*, it is so defaced, that it required much Pains and Art to render it legible, and therefore I desire the Reader's Excuse for preserving

For the making of this Sort of Dial.

You need have no regard to the *Latitude of the Place*, for that is to be considered in the *placing*, and not in the *making* of it.

[1] In order to which, prepare a Piece of *Wood or Stone* of what Size you please, and shape it in the *Form of a Cross*, so that *ab, bc, cd, de, eb, bi, ik, kl, lm*, and *ma* may be all equal: *ef*, may be more than double to *ae*: that in *London* is 25 Inches, and 5 Tenths of an Inch long from *a* to *f*, and *am* is 4 Inches and 8 Tenths, *ef* 15 Inches and 8 Tenths, and the *Depth or Thickness* is 6 Inches, 8 Tenths. This premised:

[2] Set one Foot of your *Compasses* in *e*, and draw the *Arch or Quadrant bn*, which divide into six equal *Parts*, for six *Hours*, because it is a *Quarter of a Circle* lay a *Ruler* from the *Center e*, and draw *eo, ep, eq*.

[3] Now the *Position* of this *Dial* being such that its *End am*, must face the *South*, and the upper *Part* of it to lie parallel with the *Equinoctial*, the *Sun* at 12 a-clock will shine just along the *Line ab* and *ml*. Therefore you must place 12 at *b* and *l*, then it is plain that from 12 to 3 the *Shadow of the Corner a* will pass along the *Line bc*; therefore take from the *Quadrant* just now drawn *bn* the *Distance bo*, and set it from 12 to 1.

[4] Take also *bp*, and set from 12 to 2, *bq* being equal to *bc*, at *e* place 3, where the *Shadow of the Corner a* goes quite off the *Dial* at *e*, or 3 in the *Afternoon*; but then the *Shadow of the Corner i*,

serving it, "This Dial was placed here at a Boundary of the Parish of St. Stephen, Coleman-Street, in the memorable Year 1706. and in the fifth Year of the glorious Reign of our most gracious Sovereign Queen Anne, whom GOD has preserved, Robert Trewin, Painter, Prætor."

will come on the Side *bg* at *q*, or 3 a-clock, where place the Figure 3; at *p* 4, at *o* 5, and at *b* 6 in the very Corner: because at 6 the Sun will shine right along the Line *ib*; place 6 also at the Corner *l*, because the Sun at 6 shines right along the Line *lk*, and from 6 till 9 (if it be in a Latitude where the Sun continues up so late at Night) the Shadow of the Corner at *k* is passing along the Line *lm*.

[5] Therefore take in your Compasses the Distance *bo*, and set from 6 to 7.

[6] Take *bp*, and set from 6 to 8 along the Line *lm*; and the Distance *bq* is equal to *lm*; therefore at the Corner *m*, place 9 because the Shadow of the Corner *k*, goes off the Line *lm* at 9.

[7] Then for the Morning Hours the Shadow of the Point *c* will enter upon the Line *ab* at the Point *a*, just at 3 in the Morning; therefore draw Lines from 7 and 8 in the Line *lm*, which let be drawn parallel to *am*, and having placed 3 at the Corner *a*, place 4 right against 8, 5 against 7, so will 6 be in the Corner *b*, because at 6 the Sun shines just along the Line *cb*, and from 6 till 9 the Shadow of the Point *d* is passing along the Side *ef*.

[8] Therefore having placed 6 in the Corner *e*, draw Lines from the Points *opq*, parallel to *di*, and at those Points put the Figures 7, 8, 9, for when the Shadow of the Point *d* comes to 9, the Shadow of the Point *m* is at the Point *k*, and from 9 to 12 the Shadow of *m* passeth along the Line *kl*, and at 12 the Shadow of *m*, is come to *l*.

[9] Therefore take the Distances *bo*, *bp*, *bq*, and set them from *l*, to 11 and 10, the Distance *bq* being just equal to *lk*, and thus is the Dial finished.

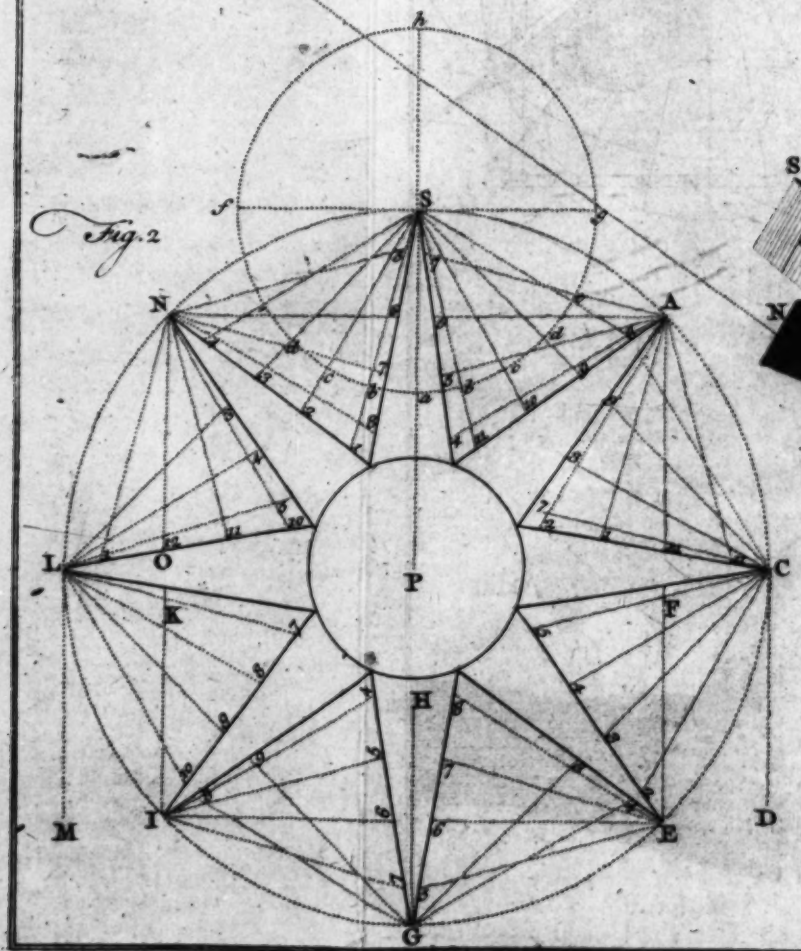
The Sun as it goes off from one Part of it comes on to another Part thereof; so that the Time of the Day



Figure 3. Is a Horizontal Dial, & shews the position
Hour Lines, according as, the Dial Plain is either a
Circle, &c. —

Fig. 3.

Fig. 2



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Position of the
other a Square.

Fig. 3

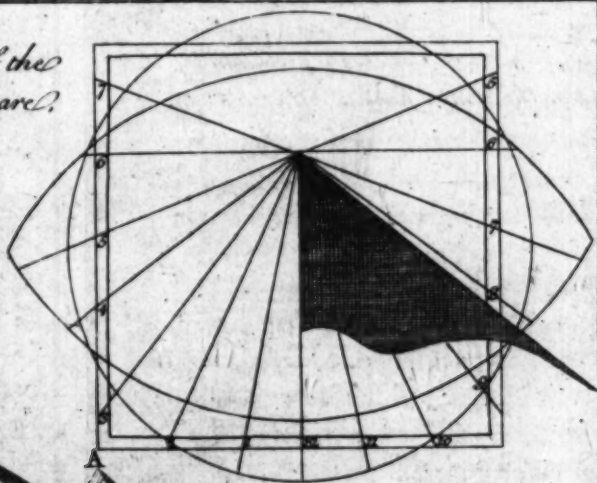
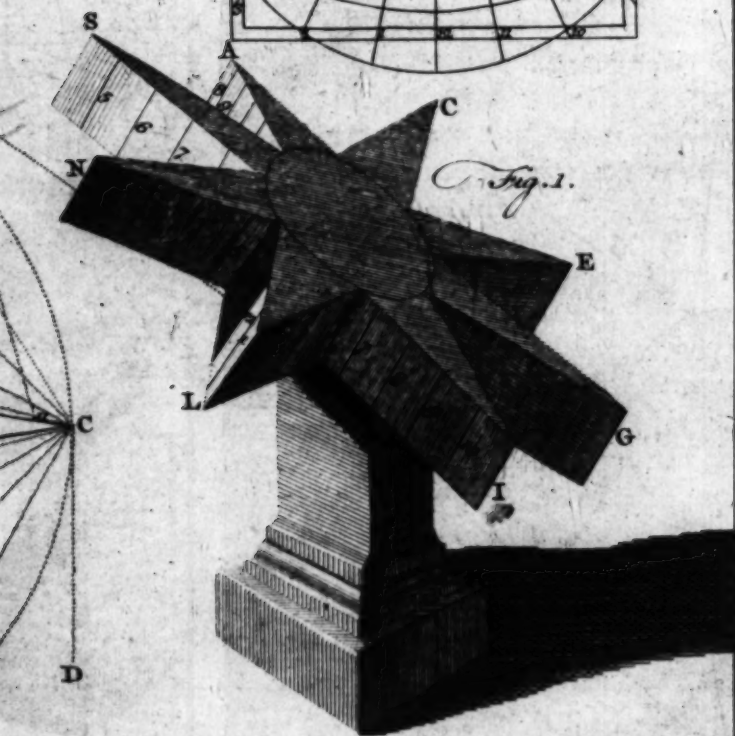


Fig. 1.



J. H. H. H. H. H.

Day may *always* be found upon *some Part* or *other* of it, when the Sun shineth.

The Reason why these Dials require *Thickness*, as well as other *Dimensions*, is because being placed *parallel to the Equinoctial*, the Sun shines upon the *upper Face* all the *Summer*, and on the *longest Day* is *elevated 23 Deg. 29 Min.* above the Plane of the Dial, and *consequently* the *Shadow* of *a* will fall at *Noon* in the *Line ab*, and not in the *Point b*, but at an *Angle* of *23 Deg. 29 Min.* therewith, (that being the Sun's greatest Declination on the longest Day.) And on the *shortest Day* the *Shadow* of *a*, will be *below* the Plane or *Line ab*, and make an *Angle* of *23 Deg. 29 Min.*

This Dial is *universal*, for when you have made one, according to the above Directions, there is nothing to do but to fix it in your Garden, &c. by help of your *Quadrant*, to the *Elevation of the Equinoctial*, or *Complement of the Latitude of your Habitation*, and so that the Side *ab* may *exactly* face the *South*.

If you would place this Dial in any place *within the Polar Circles*, you must then make all the *Ends* of an *equal* length, *viz. ef, &c. equal to ab*; otherwise, the *Shadow* would quit one Side before it comes on another, as you may the better perceive by viewing the Figure in Plate X. Fig. 3.

Of the STAR DIAL.

Plate XB.

This is an *Equinoctial Dial*, made in the *Form* of a *Star*, having eight *Rays* or *Points*, but *no Stile*, the *Thickness* of the *Ends* of the *Rays* (being perpendicular

pendicular to the Surface of the Dial) performing the Office of the *Stile* in a common *Equinoctial Dial*, by casting their *Shadows* on the *Sides* of the *Rays* or *Points*.

The only Dial we have seen of this kind is of the following Dimensions. The *Radius* of the outer imaginary Circle PS (Plate XB. Fig. 2.) is 7 Inches, and that of the inner Circle Px, 2 Inches and 1 quarter; and the *Thickness* of it 2 Inches and a half. But in order to assist the Reader's Imagination in forming a true Idea of this Dial, we have given a *perspective View* of it on Plate XB Fig 1. in which the *Hour Lines* on the Rays SNLIG are distinctly seen; and the same is to be understood of the other Rays, whose *Sides* cannot be seen in this View. *Note*, the same Rays in both figures are marked with same Letters.

The *Construction* of this Dial is the same with that of the *Equinoctial Dial*, explained in Chap. III. Page 15. The only *Difference* being, that instead of one *Stile*, which is there placed in the Center of the Dial, the End of each Ray performs the Office of a *Stile*, and therefore the whole is properly a *Composition* of eight Dials; some of these *Stiles* shew one *Hour*, and some another. Thus the *Stile*, or End of the Ray S, will, in the Morning, cast its Shadow on the Side of the Ray A, and there shew the Hours 8, 9, 10, 11; at Noon it will cast no Shadow; but in the Afternoon its Shadow will be projected on the Side of N, and shew the Hours 1, 2, 3, 4. The *Stile* or End of the Ray A, will, by casting its Shadow against the side of C, shew the Hours 11, 12, 1, 2. At three it will cast no shadow; but afterwards its Shadow will be projected on the side of S, and there shew the Hours 4, 5, 6, 7. The same is to be understood

derstood of the rest of the Rays, and is sufficiently plain from the Figure. For as the eight Rays are at equal Distances from each other, they face the Eight principal Points of the Compass. That is, the Ray S faces the South, A the South-West, C the West, E the North-West, G the North, I the North-East, L the East, and N the South-East. And as the Sun is, with regard to the Equinoctial, directly South at Noon, South-West at three, West at six, North West at nine, North at midnight, North-East at three in the Morning, East at six, and South-East, at nine; therefore the Rays respecting those Points, will then cast no Shadow. That is, the Ray L at six in the Morning will cast no Shadow, both Sides of the Ray being at that Time equally illuminated. The same is to be understood of all the rest.

In order to construct this Dial, divide the outer Circle S, C, G, L, (Plate X. B. Fig. 2) into eight equal parts, and having described a small concentric Circle P x H, draw the eight Rays S, A, C, E, G, I, L, N, as you see in the figure. Then make choice of one of the Rays to face the South, which in the Figure is that marked S. On S, the Point of this Ray, with the Radius of your Line of Chords describe a Circle, as *a g b f*; then will *S a* be the meridian Line. From *a* set off 15 Degrees both ways towards *b*, and also from *b* to *c*, from *c* to *d*, and from *d* to *e*. From S, through *b, c, d, e*, draw Lines both ways, till they cut the Sides of the next Rays A and N, which will give the Hour Lines. Those on A, because to the Westward of the Meridian Line, will be 8, 9, 10, 11, and those on N, being to the Eastward of it, 1, 2, 3, 4. The very same Method must be pursued with regard to the rest of the Rays; observing that all their Meridian Lines must be parallel to the first, *S a*.

F

Thus

Thus AB is the *Meridian Line* of A, CD of C, EF of E, GH of G, IK of I, LM of L, and NO of N. Having thus found the Places of all the *Hour Lines* on the *Projection*, transfer them to the *correspondent Rays* of the *real Dial*, and draw Lines *perpendicular to the Surface*, or *parallel to the Ends of the Rays*, which will be the *Hour Lines* required as you see in the *Perspective View* of the Dial on Plate X.B. Fig. 1.

Having thus *transfer'd* the *Hour Lines* from the *Projection* to your *Dial*, nothing remains but to *fix* it in a *true Position*. That is, to *fix it so*, that its *Surface be parallel to the Equinoctial*, and the *Ray S point directly to the South*, or to the *Sun when he is in the Meridian*. This Position is the same with that of the *Equinoctial Dial*, described in Chap. III. Page 15, where the Reader will find sufficient Instructions for this Purpose.

Thus having in the foregoing Work shewn how to make all manner of useful Dials, I think it only remains now to shew how

To make a WINDOW Dial.

By this Dial, you may know the Hour of the Day tho' the Sun *doth not shine out bright*, but appears ever so little thro' the Clouds: And so you may in the Night by the *Stars*, and *Moon*.

If your Window face any Point of the *Compass* (near the *South* is best) then find its *Declination*, as has been taught in Chap. X. then procure a large Sheet of thick writing Paper, and thereon make the Draught of your Dial (as taught in Chap. XI.) which done, either with *Wax* or a few small *Nails*, fasten your *Paper Draught* to the Plane (which I suppose to be made ready for that Purpose) upon which you design to draw the Dial. Having placed the *Center* of your *Paper Dial* in the *very Place* where you design

to fix the *Stile* in the Plane, there fasten a String, and with this *String* (or a *Ruler*) transfer the *Hours* and *Quarters* from your *Paper Draught* upon the *Window*. And this you will find to be a very easy, expeditious, and exact Way of drawing the *Hour Lines* and *Quarters* upon any Plane whatsoever. Then get an *Iron Rod* about the *Thicknes* of your *Hour Lines*, and nail it to the *Window Frame* exactly in that *Place* where the *Center* of your *Paper Draught* was placed, and set it to the *Latitude* of your *Place* by help of your *Quadrant* which is done by putting that *Edge* of it to the *Stile* wherein the *Sights* are, and raising the *Stile* higher or lower till the *Thread* cuts the *Limbe* in the *Degree* of the *Latitude* of your *Place*; and there fasten it at right *Angles* over the *Substile Line*.

You may put *Figures* (or any *Marks* for your own *Information*) to the *Hour Lines*, and thus is your *Dial* finished: and, how pleasant this will be, to sit in your *House*, &c. to see the *Time* of the *Day* that the *Sun* shines upon the *Window*, will best appear from the *Dial* when thus made: since at anytime when you can see the *Sun* just thro' the *Clouds* you may then tell the *Hour* of the *Day* as well as if it shone ever so bright; for look thro' the *Window*, and take the *Stile* between your *Eye* and the *Sun*, and at the same *Time* you'll see the *Hour* where the *Stile's* shade will fall upon the *Window*, and that is the true *Hour* of the *Day*. Also, in the *night* you may do the same by any known *Star*, by first knowing the *Time* the *Star* will be upon the *Meridian* or *South*, and as much as it wants of the *South* by the *Dial* subtracted from the *Time* of *South*ing, gives the true *Hour* of the *Night*, but if it be past the *South* by the *Dial*, add so much to the *Time* of *South*ing, and you have the *Time* of the *Night*. The same *Method* is to be used for the *Time* of the *Night* by the *Moon*.

This *Method* of transferring the *Hour Lines* from your *paper draught*, is what you may use in making of any *Dial*, which I recommend as being most practicable.

TABLE I.

A TABLE of the Sun's Declination exactly calculated for the Year 1764, which (for the Use of Dialling) will serve for this Age without any sensible Error.

	Jan.		Feb.		Mar.		April		May		June	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	23	S 00	17	S 02	7	S 30	4	N 37	15	N 08	22	N 05
2	22	55	16	45	7	07	5	00	15	26	22	13
3	22	49	16	27	6	44	5	23	15	43	22	21
4	22	43	16	09	6	21	5	46	16	01	22	28
5	22	36	15	51	5	58	6	09	16	18	22	35
6	22	29	15	32	5	34	6	31	16	35	22	41
7	22	22	15	14	5	11	6	54	16	52	22	47
8	22	14	14	55	4	48	7	16	17	08	22	53
9	22	05	14	36	4	24	7	39	17	24	22	58
10	21	56	14	16	4	01	8	03	17	40	23	01
11	21	47	13	56	3	37	8	23	17	56	23	07
12	21	37	13	36	3	14	8	45	18	11	23	11
13	21	27	13	16	2	50	9	07	18	26	23	15
14	21	16	12	56	2	27	9	28	18	40	23	18
15	21	05	12	35	2	03	9	50	18	55	23	21
16	20	54	12	15	1	39	10	11	19	09	23	23
17	20	42	11	54	1	15	10	32	19	22	23	25
18	20	30	11	33	0	52	10	53	19	36	23	26
19	20	18	11	11	0	28	11	14	19	48	23	27
20	20	05	10	50	0	04	11	35	20	01	23	28
21	19	51	10	28	0	N 19	11	55	20	13	23	29
22	19	38	10	06	0	43	12	15	20	25	23	29
23	19	24	9	44	1	07	12	35	20	37	23	28
24	19	09	9	22	1	30	12	55	20	48	23	27
25	18	54	9	00	1	54	13	15	20	59	23	25
26	18	39	8	37	2	17	13	34	21	10	23	24
27	18	24	8	15	2	41	13	53	21	20	23	21
28	18	08	7	52	3	04	14	12	21	30	23	19
29	17	52			3	27	14	31	21	39	23	16
30	17	36			3	51	14	50	21	48	23	12
31	17	19			4	14			21	57		

TABLE I.

A TABLE of the Sun's Declination exactly calculated for the Year 1764, which (for the Use of Dialling) will serve for this Age without any sensible Error.

	July		Aug.		Sept.		Octob.		Novem.		Decemb.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	23	No 8	18	No 2	8	N 10	3	S 15	14	S 31	21	S 53
2	23	04	17	47	7	54	3	38	14	50	22	02
3	22	59	17	31	7	32	4	01	15	09	22	10
4	22	54	17	15	7	10	4	24	15	28	22	18
5	22	49	16	59	6	47	4	48	15	46	22	26
6	22	43	16	43	6	25	5	11	16	04	22	33
7	22	37	16	26	6	03	5	34	16	22	22	40
8	22	30	16	09	5	40	5	57	16	40	22	47
9	22	23	15	52	5	17	6	20	16	57	22	53
10	22	16	15	34	4	55	6	43	17	14	22	58
11	22	08	15	17	4	32	7	05	17	31	23	03
12	22	00	14	59	4	09	7	28	17	47	23	08
13	21	51	14	40	3	46	7	51	18	03	23	12
14	21	42	14	22	3	23	8	13	18	19	23	16
15	21	33	14	03	2	59	8	35	18	34	23	19
16	21	23	13	44	2	36	8	58	18	49	23	22
17	21	13	13	25	2	13	9	20	19	04	23	24
18	21	03	13	06	1	50	9	42	19	19	23	26
19	20	52	12	46	1	26	10	03	19	33	23	27
20	20	41	12	27	1	03	10	25	19	46	23	28
21	20	30	12	07	0	40	10	47	20	06	23	29
22	20	18	11	47	0	16	11	08	20	13	23	29
23	20	06	11	26	0	S 07	11	29	20	25	23	28
24	19	53	11	06	0	31	11	50	20	38	23	27
25	19	40	10	45	0	54	12	11	20	50	23	25
26	19	27	10	24	1	18	12	32	21	01	23	23
27	19	14	10	03	1	41	12	52	21	12	23	21
28	19	00	9	42	2	04	13	12	21	23	23	18
29	18	46	9	21	2	28	13	32	21	33	23	14
30	18	32	8	59	2	51	13	52	21	43	23	11
31	18	17	8	38			14	12			23	06

THE EXPLANATION *and* USE

Of the foregoing

T A B L E.

THIS Table shews you the *Sun's Declination* * every Day at Noon, and is exactly calculated to the Year 1764 to the *Meridian of London*, which will serve for *this Age near enough* for any Purpose in *Dialling*.

Note, D stands for Degrees, M for Minutes, N for *North Declination*, and S for *South*.

It is of good use to find the *Latitude of the Place* of your Habitation: this may be done by taking the height of the Sun at Noon with your *Quadrant*: and if the *Sun's Declination* be *South*, ADD it to the *Altitude* or Height at Noon, but if it be *North* SUBTRACT: the Sum or Difference is the *height* of the *Equinoctial* or *Complement of the Latitude* in the *Northen Hemisphere*, but in the *Southern* use the contrary Titles.

* The *Declination of the Sun*, is his *Distance* from the *Equinoctial*, and in all Things of *this kind* the *Sun* is supposed to move *parallel* to the *Equinoctial* all *that Day*, and tho' it does not so in *fact*, yet it serves in *Dialling* *near enough* the Truth; and this *Declination* never exceeds 23 Deg. 29 Min. as appears by the Table.

Example.

Example.

Admit you are at a certain Place in the North of England, &c. and upon the 14th of February you observe the Sun's height at Noon with your Quadrant to be 22 Deg. 37 Min. what is the Latitude of Observation?

Operation.

					Deg. Min.
To the Sun's Altitude observed	—	—	—	—	22 37
Add the Sun's Declination S.	—	—	—	—	12 56
Sum is the height of the Equinoctial	—	—	—	—	35 33
Subtract it from a Quadrant or	—	—	—	—	90 00
The Latitude of the Place North is	—	—	—	—	54 27

Example 2.

					Deg. Min.
From the Sun's Altitude observed	—	—	—	—	44 51
Subtract the Sun's Declination North	—	—	—	—	10 53
Remains the Complement of the Latitude	—	—	—	—	33 58
Subtract from a Quadrant or	—	—	—	—	90 00
Remains the Latitude North	—	—	—	—	56 02

p.c. [F 4

TABLE

TABLE II.

A TABLE of the *Equation of Time* for *Regulating* Pendulum Clocks and Watches by a Sun Dial.

Days	JAN.		FEB.		MAR.		APR.		MAY		JUNE	
	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	4	6	14	13	12	48	4	1	3	8	2	47
2	4	34	14	20	12	36	3	43	3	16	2	38
3	5	2	14	27	12	23	3	25	3	23	2	29
4	5	30	14	32	12	9	3	6	3	30	2	19
5	5	57	14	37	11	55	2	48	3	36	2	9
6	6	24	14	41	11	41	2	30	3	42	1	59
7	6	50	14	44	11	26	2	13	3	47	1	48
8	7	16	14	47	11	11	1	55	3	51	1	37
9	7	41	14	48	10	56	1	38	3	55	1	26
10	8	6	14	49	10	40	1	21	3	58	1	14
11	8	30	14	49	10	24	1	4	4	0	1	2
12	8	59	14	48	10	7	0	48	4	2	0	50
13	9	22	14	47	9	50	0	32	4	4	0	38
14	9	44	14	44	9	33	0	16	4	5	0	26
15	10	5	14	41	9	16	0	1	4	5	0	13
16	10	26	14	37	8	58	0	14	4	5	0	1
17	10	46	14	33	8	40	0	29	4	4	0	12
18	11	5	14	28	8	22	0	43	4	2	0	25
19	11	24	14	22	8	4	0	57	4	0	0	38
20	11	42	14	15	7	46	1	11	3	58	0	50
21	11	59	14	8	7	27	1	24	3	55	1	3
22	12	15	14	0	7	9	1	37	3	51	1	16
23	12	30	13	52	6	50	1	49	3	47	1	29
24	12	45	13	43	6	31	2	1	3	42	1	42
25	12	59	13	33	6	13	2	12	3	37	1	55
26	13	12	13	22	5	54	2	23	3	31	2	7
27	13	24	13	12	5	35	2	33	3	25	2	20
28	13	36	13	0	5	16	2	43	3	18	2	32
29	13	46		4	57	2	52	3	11	2	44	
30	13	56		4	39	3	0	3	3	2	56	
31	14	5			4	20			2	55		

TABLE II.

A TABLE of the Equation of Time for Regulating Pendulum Clocks and Watches by a Sun Dial.

Days	JULY		AUG.		SEP.		OCT.		NOV.		DEC.	
	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	3	8	5	46	0	18	10	23	16	13	10	32
2	3	19	5	42	0	36	10	42	16	13	10	9
3	3	31	5	31	0	55	1	9	16	13	9	45
4	3	42	5	33	1	14	11	18	16	12	9	20
5	3	52	5	28	1	34	11	36	16	10	8	55
6	4	2	5	22	1	54	11	53	16	8	8	29
7	4	12	5	10	2	14	12	10	16	4	8	8
8	4	22	5	8	2	34	12	27	16	0	7	37
9	4	31	5	0	2	54	12	43	16	54	7	10
10	4	40	4	52	3	14	12	58	15	48	6	48
11	4	48	4	43	3	35	13	13	15	41	6	14
12	4	56	4	34	3	55	13	28	15	34	5	46
13	5	4	4	24	4	16	13	42	15	25	5	18
14	5	11	4	13	4	37	13	56	15	16	4	49
15	5	17	4	2	4	58	14	9	15	6	4	19
16	5	23	3	50	5	19	14	22	14	55	3	50
17	5	29	3	38	5	40	14	33	14	43	3	20
18	5	34	3	26	6	1	14	45	14	30	2	51
19	5	39	3	14	6	22	14	56	14	16	2	21
20	5	43	2	59	6	42	15	6	14	2	1	51
21	5	46	2	45	7	3	15	15	13	46	1	20
22	5	49	2	30	7	24	15	24	13	30	0	50
23	5	51	2	15	7	44	15	32	13	13	0	20
24	5	53	2	0	8	5	15	40	12	56	0	10
25	5	54	1	44	8	25	15	46	12	38	0	40
26	5	55	1	28	8	45	15	52	12	18	1	10
27	5	55	1	11	9	5	15	58	11	58	1	40
28	5	54	0	54	9	15	16	2	11	28	2	10
29	5	53	0	36	9	45	16	6	11	17	2	39
30	5	51	0	19	10	4	16	0	10	55	3	8
31	5	49	0	1			16	11				31

EXPLANATION *and* USE

Of the foregoing

T A B L E.

THIS is a Table of *Equation of Time*, that is, it shews you what the Sun gains or loses of the Pendulum Clock every Day; for the Pendulum Clock keeps *equal Time* all the Year round, tho' the Sun doth not do so, but is *very unequal* in its Motion, *sometimes too fast*, and at other Times *too slow*, as the Table plainly shews; so that if at any Time you want to set your Clock or Watch by your Sun-Dial you must look into this Table, and observe what the *Equation* is on that Day, and set it accordingly, so many Minutes and Seconds, faster or slower, as you see the Clock is *too fast* or *too slow* for the Sun.

For Instance, January 14 at Noon, I see the Clock is 9 Min. 44 Seconds *too fast* for the Sun, &c. therefore the Clock should be set 9 Min. 44 Seconds *faster* than a Sun Dial.

On May the 10th, at Noon the Clock is 3 Min. 58 Seconds, *too slow*; therefore when it is *twelve* by a Sun Dial, the Clock must be set to 56 Min. 2 Seconds *after Eleven*.

TABLE

TABLE III.

A TABLE for converting *Hours* and *Minutes of Time* into *Degrees and Minutes of the Equinoctial*; and for the turning of *Degrees and Minutes of the Equinoctial* into *Hours and Minutes of Time*.

H	o	'	o	'	o	'	o	'	o	'
I	I	II	I	II	II	I	II	II	I	II
II	II	III	II	III	III	II	III	III	II	III
1	15	1	0	15	21	5	15	41	10	15
2	30	2	0	30	22	5	30	42	10	30
3	45	3	0	45	23	5	45	43	10	45
4	60	4	I	0	24	6	0	44	II	0
5	75	5	I	15	25	6	15	45	II	15
6	90	6	I	30	26	6	30	46	II	30
7	105	7	I	45	27	6	45	47	II	45
8	120	8	2	0	28	7	0	48	12	0
9	135	9	2	15	29	7	15	49	12	15
10	150	10	2	30	30	7	30	50	12	30
11	165	11	2	45	31	7	45	51	12	45
12	180	12	3	0	32	8	0	52	13	0
13	195	13	3	15	33	8	15	53	13	15
14	210	14	3	30	34	8	30	54	13	30
15	225	15	3	45	35	8	45	55	13	45
16	240	16	4	0	36	9	0	56	14	0
17	255	17	4	15	37	9	15	57	14	15
18	270	18	4	30	38	9	30	58	14	30
19	285	19	4	45	39	9	45	59	14	45
20	300	20	5	0	40	10	0	60	15	0
21	315	Note { H } stand for { Hours o { ' } Degrees ' { II } Minutes II { III } Seconds III { } Thirds								
22	330									
23	345									
24	360									

EXPLANATION and USE

Of the foregoing

TABLE.

THIS Table shews how to convert *Time into Motion*, and *Motion into Time*; as suppose I had 5 Hours 13 Min. 29 Seconds to be turned into Degrees and Minutes of the Equinoctial, i. e. into *Motion*; the Operation stands thus.

		D. M. S.	
5 Hours	=	75 0 0	} add
13 Minutes	=	3 15 0	
29 Seconds	=	0 7 15	
The Sum	— — —	78 22 15	for answer.

Again, suppose I would turn 78 Deg. 22 Min. 15 Seconds into *Time*, then the work will stand thus.

		H. M. S.	
Degrees	75 =	5 0 0	} add
Degrees	3 =	0 12 0	
Minutes	15 =	0 1 0	
Minutes	7 =	0 1 28	
Seconds	15 =	0 0 1	
The Sum	— — —	5 14 29	for answer.

N. B. There being the same Number, either of Minutes, Seconds or Thirds in an Hour, as there are Minutes, Seconds or Thirds in a Degree; therefore the Head of each Column in the Table is marked with three different Characters, that the same Column might serve for either. Thus against 12 in the third Column (marked at the Top with 12, 12, 12) stands 3. 0. in the fourth Column, and signifies either 3 Degrees, 3 Minutes, or 3 Seconds according as the first signified either 12 Minutes, 12 Seconds, or 12 Thirds, and the same is to be understood of the rest.

TABLE

TABLE IV.

A TABLE of *Meridional Angles*, shewing the *Degrees* of each *Hour Line* from 12 a-clock, upon all *Horizontal* and *North and South Erect Direct Reclining and Inclining Dials*, from the *Equinoctial* to the *Poles*.

Hour, Dial Lat.	XI		IX		II IX		III VIII		IV VII		V VI		S. or N. Lat.
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
0	0	00	0	00	0	00	0	00	0	00	00	0	00
1	0	16	0	34	1	00	1	44	3	44	00	0	34
2	0	32	1	9	2	00	3	27	7	25	00	0	88
3	0	48	1	44	3	00	5	11	11	3	00	0	87
4	1	5	2	19	4	00	6	54	14	36	00	0	86
5	1	20	2	52	4	58	8	35	18	1	00	0	85
6	1	36	3	27	5	58	10	16	21	19	00	0	84
7	1	52	4	3	6	57	11	55	24	27	00	0	83
8	2	8	4	37	7	55	13	33	27	23	00	0	82
9	2	23	5	9	8	54	15	10	30	17	00	0	81
10	2	40	5	43	9	51	16	44	32	55	00	0	80
11	2	55	6	17	10	48	18	17	35	27	00	0	79
12	3	11	6	51	11	45	19	40	37	49	00	0	78
13	3	27	7	24	12	41	21	17	40	1	00	0	77
14	3	43	7	57	13	36	22	44	42	4	00	0	76
15	3	58	8	30	14	31	24	0	44	0	00	0	75
16	4	13	9	2	15	25	25	31	45	49	00	0	74
17	4	29	9	35	16	26	26	52	47	27	00	0	73
18	4	44	10	8	17	10	28	9	49	4	00	0	72
19	4	59	10	39	18	2	29	25	50	33	00	0	71
20	5	14	11	10	18	53	30	39	51	55	00	0	70
21	5	29	11	41	19	44	31	50	53	9	00	0	69
22	5	44	12	12	20	32	32	58	54	21	00	0	68
23	5	59	12	43	21	20	34	5	55	30	00	0	67
24	6	14	13	13	22	8	35	10	56	37	00	0	66
25	6	28	13	43	22	55	36	12	57	34	00	0	65
26	6	42	14	12	23	40	37	13	58	34	00	0	64
27	6	56	14	41	24	25	38	11	59	27	00	0	63
28	7	10	15	10	25	9	39	7	60	17	00	0	62
29	7	24	15	40	25	52	40	2	61	4	00	0	61
30	7	38	16	6	26	33	40	54	61	49	00	0	60

TABLE IV.

TABLE IV.																	
A TABLE of Meridional Angles, shewing the Degrees of each Hour Line from 12 a-clock, upon all Horizontal and North and South Erect Direct Reclining and Inclining Dials, from the Equinoctial to the Poles.																	
Hor. Dial Lat.	XI		IX		III		VIII		IV		VII		V		VI		South Dial Lat.
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	M.		
31	7	50	16	34	27	15	41	44	62	30	90	0	59				
32	8	5	17	1	27	55	42	30	63	11	90	0	58				
33	8	19	17	27	28	34	43	20	63	49	90	0	57				
34	8	31	17	54	29	13	44	5	64	24	90	0	56				
35	8	44	18	20	29	50	44	49	64	58	90	0	55				
36	8	57	18	49	30	27	45	31	65	30	90	0	54				
37	9	10	19	9	31	2	46	12	66	10	90	0	53				
38	9	22	19	34	31	37	46	50	66	29	90	0	52				
39	9	34	19	58	32	11	47	28	66	56	90	0	51				
40	9	45	20	21	32	44	48	7	67	21	90	0	50				
41	9	57	20	44	33	16	48	39	67	47	90	0	49				
42	10	10	21	7	33	46	49	12	68	11	90	0	48				
43	10	22	21	29	34	18	49	44	68	33	90	0	47				
44	10	32	21	51	34	47	50	10	68	54	90	0	46				
45	10	44	22	12	35	17	50	46	69	15	90	0	45				
46	10	54	22	33	35	44	51	15	69	35	90	0	44				
47	11	5	22	53	36	11	51	42	69	53	90	0	43				
48	11	16	23	13	36	37	52	9	70	11	90	0	42				
49	11	25	23	33	37	3	52	35	70	28	90	0	41				
50	11	35	23	52	37	28	53	0	70	43	90	0	40				
51	11	45	24	9	37	52	53	24	70	59	90	0	39				
52	11	55	24	27	38	15	53	46	71	13	90	0	38				
53	12	5	24	43	38	37	54	12	71	28	90	0	37				
54	12	13	25	2	38	58	54	29	71	41	90	0	36				
55	12	22	25	18	39	19	54	49	71	54	90	0	35				
56	12	32	25	34	39	40	55	9	72	5	90	0	34				
57	12	40	25	50	39	50	55	28	72	17	90	0	33				
58	12	45	26	5	40	1	55	45	72	28	90	0	32				
59	12	56	26	20	40	36	56	37	72	38	90	0	31				
60	13	4	26	34	40	54	56	19	72	48	90	0	30				

TABLE IV.

A Table of *Meridional Angles* shewing the *Degrees* of each *Hour Line* from 12 a clock, upon all *Horizontal* and *North* and *South Erect Direct Reclining* and *Inclining* Dials, from the *Equinoctial* to the *Poles*.

Hor. Dial Lat.	XI		X		IX		VIII		VII		VI	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
61	13	11	26		47	41	10	56	34	72	58	90
62	13	19	27		41	41	21	56	49	73	79	90
63	13	26	27		13	41	42	57	37	73	15	90
64	13	32	27		25	41	57	57	17	73	24	90
65	13	36	27		37	42	15	57	30	73	32	90
66	13	46	27		49	42	25	57	43	73	39	90
67	13	51	27		59	42	38	57	54	73	46	90
68	13	57	28		9	43	50	58	57	73	53	90
69	14	3	28		19	43	2	58	16	73	59	90
70	14	7	28		29	43	13	58	26	74	59	90
71	14	13	28		37	43	19	58	35	74	11	90
72	14	18	28		46	43	24	58	54	74	16	90
73	14	22	28		54	43	36	58	52	74	20	90
74	14	27	29		2	43	52	59	00	74	25	90
75	14	30	29		7	44	00	59	7	74	30	90
76	14	33	29		15	44	8	59	15	74	34	90
77	14	37	29		2	44	14	59	22	74	37	90
78	14	41	29		37	44	22	59	27	74	40	90
79	14	44	29		32	44	28	59	32	74	44	90
80	14	47	29		37	44	34	59	37	74	47	90
81	14	49	29		41	44	37	59	40	74	49	90
82	14	51	29		45	44	40	59	44	74	51	90
83	14	53	29		49	44	44	59	47	74	53	90
84	14	55	29		52	44	48	59	51	74	55	90
85	14	56	29		54	44	53	59	54	74	57	90
86	14	57	29		55	44	55	59	55	74	58	90
87	14	58	29		56	44	56	59	56	74	58	90
88	14	59	29		57	44	57	59	58	74	59	90
89	14	59	29		58	44	58	59	59	74	59	90
90	15	00	30		00	44	00	60	00	75	00	90

EXPLANATION *and* USE

Of the foregoing

T A B L E.

THIS is a Table of *Meridional Angles*; the *first Column* is the *Latitude*, which serves for an *Horizontal Dial*, and the *last Column* is the *Complement of the Latitude*, and is for making *Erect Direct South* or *NORTH Dials*, and are thus to be used:

✍ Suppose in the *Latitude* of 53 *Deg.* I would make an *Horizontal*, and also an *Erect Direct South Dial*.

First, *For the Horizontal Dial.*

See Plate 3. Fig. 2.

Now (altho' this be projected for a *higher Latitude*, yet it may serve our Turn here well enough to shew how to use the Table:) I look into the Table, and find against 53 *Deg.* and under 11 and 12 o'clock 12 *Deg. 5 Min.* Take this 12 *Deg. 5 Min.* in your Compasses (from the *Line of Chords*, that you draw the *Quadrant AB* by) and set one foot in the *Meridian CA*, and turning the *other* each Way, it shall give the *Points* where the *Hour Lines* of 11 and 12 must pass; under 10 and 2, and against the *same Latitude* 53, I find 24 *Deg. 43 Min.* which take from the *Line of Chords*, and set each Way from the *Meridian*

Meridian as before, and it gives the 10 and 2 a-clock *Hour Lines*. For the Hours 9 and 3 you must take 38 Deg. 37 Min. for 8 and 4 a-clock, you must set 54 Deg. 12 Min. and for 5 and 7 set 71 Deg. 28 Min. the *Chord* of 90 gives the 6 a-clock *Hour Line*, and so by drawing *Hour Lines* from the Center thro' these Points, thus set off in the *Arch* A B, are the true *Hour Lines* required.

Secondly, *For the Erect Direct South Dial.*

See Plate 4. Fig. 2.

Suppose I would make an *Erect Direct South Dial* for the *Latitude* of 53 Deg. the Work in this is the very same as I have shewn in the *Horizontal Dial*; only here you must seek your *Latitude* in the last Column on the right Hand, or its *Complement* on the left Hand; and against either, for 1 and 12 a-clock, 9 Deg. 10 Min. for 10 and 2, 19 Deg. 9 Min. are to be set off from the *Meridian* by your *Line of Chords*; for 9 and 3 a-clock are 31 Deg. 2 Min. for 8 and 4 a-clock are 46 Deg. 12 Min. for 7 and 5 a-clock are 66 Deg. 10 Min. and for 6 a-clock are 90, and thus for any *Latitude* of even Degrees, an *Horizontal* and *South Direct Dial* may be expeditiously made by help of this *Table* and your *Line of Chords*.

What has been said of the *South Erect Dial* is also applicable to the *North*, and therefore needs no Example.

G

TABLE

TABLE V.

A TABLE of the *Three Requisites* in *Dialling*, shewing the *Substile's Distance* from the *Meridian*, the *Stile's Height*, and the *Inclination*.

Declination.	Substile's Distance from the Meridian.	STILE's Height.	Inclination of Meridians.
Degrees.	Degrees. Minutes.	Deg. Min.	Degrees. Minutes.
1	0 48	38 29	1 17
2	1 36	38 28	2 33
3	2 23	38 26	3 49
4	3 11	38 23	5 7
5	3 58	38 20	6 23
6	4 45	38 15	7 39
7	5 32	38 10	8 55
8	6 19	38 4	10 11
9	7 5	37 57	11 27
10	7 52	37 49	12 42
11	8 38	37 40	13 57
12	9 23	37 30	15 10
13	10 8	37 21	16 26
14	10 54	37 10	17 40
15	11 38	36 58	18 54
16	12 22	36 45	20 7
17	13 5	36 32	21 20
18	13 42	36 18	22 33
19	14 31	36 3	23 45
20	15 13	35 48	24 57
21	15 54	35 31	26 8
22	16 36	35 16	27 18
23	17 16	34 57	28 29
24	17 56	34 39	29 38
25	18 37	34 21	30 47

T A B L E V.

tion of Meridians for the Latitude of London, answerable to the several Degrees of Declination of your Plane. N.B. How to find these Requisites for any other Place, is shewn in Chap. XI.

Declination.	Substile's Distance from the Meridian.		STILE'S Height.	Inclination of Meridians.
Degrees.	Degrees. Minutes.		Deg Min.	Degrees. Minutes.
20	19	12	34 1	31 56
27	19	50	33 42	33 4
28	20	27	33 20	34 12
29	21	5	32 59	35 19
30	21	40	32 37	36 25
31	22	15	32 15	37 31
32	22	50	31 52	38 36
33	23	25	31 27	39 41
34	23	59	31 14	40 46
35	24	31	30 40	41 49
36	25	4	30 14	42 52
37	25	35	29 48	43 55
38	26	4	29 22	44 58
39	26	35	28 56	45 59
40	27	3	28 29	47 0
41	27	33	28 1	48 0
42	28	1	27 33	49 0
43	28	29	27 5	50 0
44	28	55	26 36	50 59
45	29	21	26 7	51 57
46	29	46	25 37	52 55
47	30	11	25 7	53 53
48	30	35	24 38	54 50
49	30	58	24 6	55 46
50	31	21	23 35	56 42

TABLE V.

A TABLE of the *Three Requisites* in *Dialing*, shewing the *Substile's Distance* from the *Meridian*, the *Stile's Height*, and the *Inclination* of *Meridians*.

Declination.	Substile's Distance from the <i>Meridian</i> .		STILE's Height.		Inclination of <i>Meridians</i> .	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
51	31	45	23	4	57	38
52	32	5	22	32	58	33
53	32	26	22	0	59	28
54	32	46	21	28	60	23
55	33	6	20	55	61	17
56	33	24	20	22	62	10
57	33	42	19	49	63	4
58	34	0	19	16	63	57
59	34	13	18	42	64	49
60	34	33	18	6	65	41
61	34	47	17	34	66	33
62	35	5	17	0	67	24
63	35	18	16	25	68	16
64	35	32	15	50	69	7
65	35	45	15	15	69	57
66	36	0	14	40	70	47
67	36	13	14	5	71	38
68	36	25	13	29	72	27
69	36	36	12	53	73	16
70	36	45	12	11	74	6

TABLE V.

tion of Meridians for the Latitude of London,
answerable to the several Degrees of Declina-
tion of your Plane. N.B. How to find these Re-
quisites for any other Place, is shewn in Chap. XI.

Declination.	Substile's Distance from the Meridian.	STILE's Height.	Inclination of Me- ridians.
Degrees.	Degrees. Minutes.	Deg Min.	Degrees. Minutes.
71	36 55	11 41	74 55
72	37 6	11 6	75 44
73	37 15	10 29	76 33
74	37 24	9 53	77 21
75	37 32	9 10	78 9
76	37 40	8 40	78 57
77	37 47	8 3	79 46
78	37 53	7 27	80 33
79	37 59	6 40	81 21
80	38 4	6 12	82 0
81	38 9	5 35	82 36
82	38 14	4 58	83 43
83	38 17	4 20	84 31
84	38 21	3 44	85 18
85	38 23	3 6	86 5
86	38 26	2 28	86 52
87	38 28	1 52	87 39
88	38 29	1 15	88 26
89	38 29	0 37	89 13
90	38 30	0 0	90 0

T H E

EXPLANATION *and* USE

Of the foregoing

T A B L E.

LASTLY, The Table of the *Three Requisites* in *Dialling* is explained in Chap. XI. where I have shewn how to find the *Substile's Distance* from the *Meridian*, the *Stile's height*, and the *Inclination of Meridians* for *Latitude 53 Deg. 22 Min.* and the *Plane's Declination 21 Deg. 10 Min. West*, which may serve as a *standing Rule* for any other *Latitude* and *Declination* whatsoever.

T A B L E

TABLE VI.

A TABLE shewing the *Sun's Altitude* every *Hour and Quarter of the Day*, at his Entrance into the 12 *Signs of the Zodiack* for the *Latitude of London 51 Deg. 32 Min. North*.

N. B. This Table is useful in drawing *reflective Dials*.

Hours.	♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
X. I	61 57	58 39	49 58	38 28	26 58	18 17	14 59					
1	61 48	58 34	49 52	38 22	26 52	18 10	14 52					
2	61 22	58 8	49 82	38 4	26 37	17 56	14 39					
3	60 39	57 27	48 57	37 36	26 12	17 34	14 18					
I XI	59 42	50 33	48 10	36 56	25 37	17 3	13 48					
1	58 29	55 25	47 11	36 5	24 53	16 24	13 9					
2	57 4	54 6	46 1	35 4	24 1	15 36	12 23					
3	55 29	52 34	44 40	33 58	22 59	14 19	11 29					
II X	53 45	50 55	43 11	32 36	21 49	13 36	10 28					
1	51 53	49 7	41 52	31 8	20 31	12 24	9 19					
2	49 54	47 12	39 37	29 34	19 6	11 6	8 3					
3	47 51	45 13	37 57	27 53	17 36	9 42	6 41					
III IX	45 42	43 7	35 59	26 5	15 57	8 11	5 13					
1	43 31	40 58	33 57	22 12	14 13	6 34	3 39					
2	41 15	38 45	31 49	22 25	12 23	4 51	1 59					
3	38 59	36 30	29 40	20 13	10 30	3 5	0 15					
IV VIII	36 40	34 14	27 28	18 7	8 32	1 13						
1	34 23	31 50	25 13	15 58	6 31							
2	32 4	29 37	22 56	13 46	4 25							
3	29 43	27 16	20 37	11 32	2 16							
V VII	27 23	24 5	18 18	9 17	0 5							
1	25 4	22 37	15 5	6 58								
2	22 46	20 17	13 35	4 39								
3	20 28	17 57	11 1	2 20								
VI VI	18 12	15 42	9 6									
1	15 58	14 0	6 41									
2	13 46	11 13	4 22									
3	11 37	9 1	2 8									
VII V	9 30	6 52										
1	7 25	4 46										
2	5 24	2 42										
3	3 27	0 43										
VIII IV	1 34											

EXPLANATION *and* USE

Of the foregoing

T A B L E.

THIS Table shews the *Sun's Height* or *Altitude* at every *Hour* and *Quarter* of the Day, for the *Latitude* of *London*, and is useful in drawing *Hour Lines* upon your *Quadrant*,* and also for drawing the *Hour Lines* upon the *Cieling* of your Room in the *Reflective Dial*, and by your *Quadrant* you may find the *Sun's Altitude* at any *Time* of the Day, wherever you are, by holding your *Quadrant* up and looking through the *Sights* at the *Sun*, and the *Thread* will cut the *Limb* or *Arch* of the *Quadrant* in the *Degrees* of the *Sun's height* at that *Time* and *Place*; the *Minutes* must be guessed at, because every *Degree* being supposed to be divided into 60 equal *Parts* called *Minutes*, and those *Divisions* called *Degrees* being *small*, it is impossible they should actually be divided into *Minutes* or 60 equal *Parts*, so that if the *Thread* cuts a *Quarter* of a *Degree*, then call the *Minutes* 15, if it cuts one *Third* of a *Degree*, call them 20 *Minutes*, if a *half* 30, if two *Thirds* 40, if three *Fourths*, then the *Minutes* are 45, &c. and thus you may take the *Height* of the *Moon* and *Stars*. And by this means you may make the like Table for your own or any other *Latitude*.

* For further Satisfaction herein you may see my *System of Astronomy*, Vol. I. Page III.

CHAP. XX. *Shewing the Use of the Scales in Plate II.*

IN *Prob.* 9, 10, 11, and 12, I have shewn how to make the *Scales* in Plate II. and in *Chap.* XVI. *Page* 56, I have shewn how to use the *Line of Chords*, in measuring of any *right lined Angles*. The *Lines of Hours* and *Latitudes* are general for pricking down all *Dials with Centers*, as the *Horizontal, South Direct*, &c. as for

Example.

Let it be required to draw a *Dial* upon an *Horizontal Plane* for the *Latitude of London* 51 Deg. 32 Min.

See Plate 11. Fig. 1.

For the Hour Lines and Stile's height.

Draw CD for the *Meridian*, or *Hour Line* of 12, and cross it at *right Angles* in C, with AB; then from the *Scale of Latitudes*, set off CA and CB each equal to 51 Deg. 32 Min. for the *Stile's height*. Then take the whole *Scale of Six Hours* in your *Compasses*, and set it from A to D; draw AD and BD: Divide the *Lines AD* and *BD* as the *Scale of six Hours* is divided, and thro' those *Divisions* draw *Lines* to the *Center C*, which shall be the true *Hour Lines* sought, to which put their *proper Figures* as you see done in the *Dial*.

This is a very ready and easy way to describe the *Hour Lines* on any *Plane*.

For

For the Stile.

Take CA in your Compasses, and set from D to E, draw CE for the *Stile*, which must stand *perpendicular* upon the Line CD, and so is your Dial completely finished.

Ever remember to make an Allowance for the *Thickness* of the *Stile* in all Dials, as I have cautioned you before.

An Example.

Of a *North* and *South* Erect Direct Dial for *Penzance* in *Cornwall*, whose *Latitude* is 50 Deg. 8 Min. N.

See Plate 11. Fig. 2.

This Dial is made the very same Way as I have just now shewn in the *Horizontal Dial*, only instead of taking the *Latitude* from the *Scale of Latitudes*, you must here in this Dial take the *Complement of the Latitude of the Place*, viz. 39 Deg. 52 Min. and set it from C to A, and B, which is also the *Stile's* height.

For the Hour Lines of the South and North Dials.

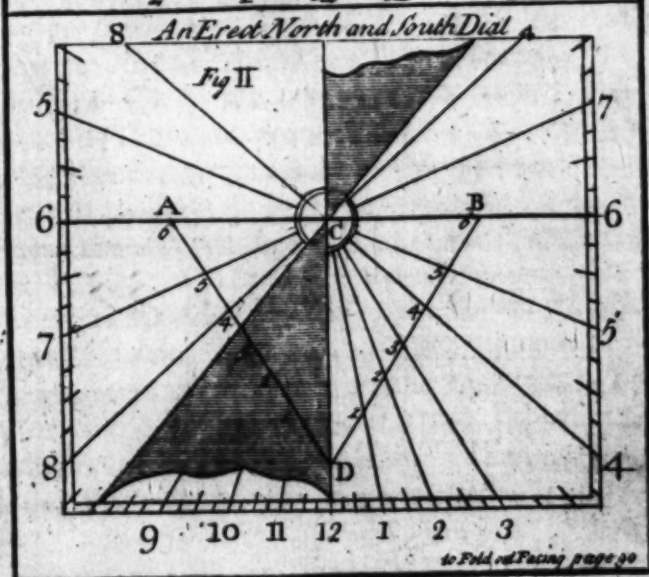
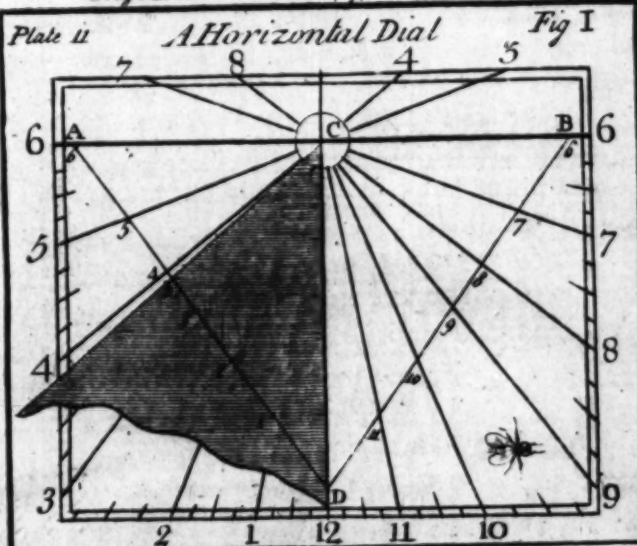
Take the *Scale of six Hours*, and set from A to D, draw AD and BD, then take in your Compasses each Hour severally from the *Scale of six Hours*, and mark them off in the Lines AD and BD; thro' those Points, draw Lines from the Center C, and they shall be the true Hour Lines required.

For the Stile.

Set AC from D to E, and continue it beyond the Center C, which shall be the *Stiles* for the *North* and *South* Dial, as you see done in the Dials.

By

These Dial are made by $\frac{1}{2}$ scales in Plate 2





Chap. XX. Of the Use of the Scales in Plate II. 91

By the *Scale of Inclinations* is known in *erect Decliners*, where the *substilar Line* will fall; which must always be on the *contrary Side* the *Meridian Line* or *Hour Line* of 12; that is, if the Plane declines *Westward* the *substilar Line* must stand on the *East side*, but if the Plane declines *Eastward*, then the *substilar Line* must be placed on the *West-side* the *Meridian*: and if the *Inclination of Meridians* be less than 15 *Deg.* the *substilar Line* will fall between 11 and 12, or between 12 and 1 a-clock, according to which *Point of the Heavens* the Plane declines: if the *Inclination of Meridians* be more than 15 *Deg.* but less than 30, the *substilar Line* will fall between the Hours of one and two, &c. Some *Dialists* put the *Difference of Meridians* of several Places, as *Jerusalem, Madrid, &c.* upon the Dial, to shew the Time of the Day at *those* Places, as well as the Time *where you are*; but this is needless; for if at any Time you would know what a-clock it is at any Place in the known World, when it is such a Time at *London*, only turn to the Table of the *Latitude and Longitude* of Places at the End of this Treatise, and there see what the *Difference of Meridians* is; and if the Place be to the *East of London*, add the *Difference of Meridians in Time* to the Time at *London*, which gives the Time at *that* Place; but if it lie to the *West*, subtracting the *Difference of Meridians in Time* from the Time at *London*, gives you the Time of the Day at *that* Place.

Example.

Suppose it is 10 a-clock in the *Forenoon* at *London*, what Time is it *then* at *Constantinople*, and also at *Port Royal in Jamaica*?

Given

92 *Of the Use of the Trigon.* Chap. XX.

	H.	M.
Given Time at London is	—	—
Constantinople to the East (add)	—	—
		10 00
Time at Constantinople	—	—
		11 59

That is 59 Min. *past* Eleven in the *Forenoon*.

Again.

	H.	M.
Given Time at London is	—	—
Port Royal to the West (subtract)	—	—
		10 00
Time at Port Royal in the Morning	—	—
		5 4
		4 56

The like of any other Place in the *Catalogue*.

The Use of the TRIGON.

See the Figure on Page 10.

You are to take notice, that the *Parallels of the Signs*, the *daily Arches*, the *Circles of Altitude*, and all other *Circles* relating to the *Course of the Sun*, when they are described upon any *Sun Dial*, are not shadowed out by the *whole Stile*, or *Axis of the Dial* as the *Hours* are, but by some *one Point* in the same *Stile* or *Axis*; as by a *Knob*, *Button* or *Notch*, filed in the *Stile* of the *Dial*, or by a *Hole in a Glass Window* for *projected Dials*, or by a *Piece of Looking Glass* for *reflected Dials*; in all which Cases the *Trigon at C* is to be applied, so that the *Line* thereof marked *AB*, must lie upon the *Stile* of the *Dial*, or *parallel* to the *Axis of the World*, if it be an *Hole in a Window*, or a *Piece of Looking-Glass*: And now, the *Trigon* being thus placed with the *Equinoctial CD* $\perp$ *perpendicular to the Stile*, the *Center* being always fixed upon the *Button* or *Notch*, or *Knob*, so that you may turn it about the *Axis*, as occasion shall require.

For

For the Equinoctial.

Now suppose you would insert the *Equinoctial* into any Dial, (for *one Rule serves for all Planes.*) First, put a *Thread* through the little *Hole* marked with $\bullet$ at γ and Δ , tying a *Knot* on the *Thread* that it slips not through the *Hole* in the *Trigon*; then put the *Center C* to the *Knob* in the *Stile*, and the *Side AB* to the *Stile* itself: This done, extend the *Thread* over the *Line CD* γ till it touches the *Dial Plane*: that *Point of touching* shall be *one Point* through which the *Equinoctial* is to be drawn upon the *Plane*: Then turning the *Trigon* about still keeping the *Line AB* parallel to the *Stile*, extend the *Thread* till it touch the *Dial Plane* in some other *Point*, and that shall be *another Point*, through which the *Equinoctial* is to be drawn upon the *Dial*.

And if your *Dial* be all but *one plain Superficies*, *two Points* will be sufficient to draw the *Equinoctial* by, it being a *great Circle* of the *Sphere*, and consequently a *right Line* upon all *plain Superficies*. But,

If the *Dial* consist of *more than one Plane*, then must you, in the same manner as before, find *two Points at least* upon *each Superficies*; which you may easily and speedily do by turning the *Trigon* about the *Stile*, and keeping the *Side AB* parallel thereto, extending the *Thread* over the *Line CD* γ till it touch the *Plane*.

For the Tropick of Cancer,

In like manner if you would insert the *Tropick of Cancer* into your *Dial*, you must put the *Thread* in the *Hole* at ω , and then apply the *Center C* to the *Knob*

Knob in the *Stile*, keeping the Side *AB* parallel to the *Stile* (as before) extend the Thread over the Line *C^m* till it touch the Plane, and that Point of touch must be one Point through which the *Tropick of Cancer* must pass.

Again move the *Trigon* in the same Position upon the *Stile* of the *Dial* as occasion requires; extend the Thread over the *Tropick C^m* till it touch the Plane, and that shall be another Point through which the *Tropick* must be drawn, and in this manner you may find as many Points upon the Plane as you please, and the more the better, for these *Parallels* will not be straight Lines, as the *Equinoctial Line* was, but conic or curved Lines, through which Points a Line being traced, with an even hand, shall be the *Tropick of Cancer* upon your *Dial Plane*.

For the Tropick of Capricorn.

And in this manner may the *Tropick of Capricorn*, and all the *Parallels* of the other Signs (or any other *Parallel* of the *Sun's Declination*) be drawn on your *Dials*, if first you put the Thread through the respective Hole, and apply the *Trigon* to the *Stile*, and extend the Thread over the *Parallel of Declination* till it touch the Plane; and thus you may find as many Points as you please, thro' which to draw your *Parallels*; and this may suffice for the Inscription of the *Parallels* of the Signs of the *Zodiack*.

And if you would insert the *Parallels* for the length of the Day, they are to be done in the same manner, if instead of the *Declinations for the Signs*, you put into your *Trigon* the *Parallels* for the length of the Days you intend to insert into your *Dial*.

N. B. In Page 90 I have given a caution to all *Dialists*, that they be careful always to make Allowance for the Thickness of the *Stile*, otherwise the *Dial* will err from the Truth.

CHAP. XXI. *A Review of the Equinoctial and Direct East and West Dials.*

Of the Equinoctial Dial, after what is said concerning it in
CHAP. III.

IF to this you add a *Semicircle* to represent *one half* of the *Meridian*, and graduate the *Meridian* unto 180 Deg. by two Ninety's, and set it in a Notch over a Box and Needle well touched with a Loadstone, it will shew you the Hour of the Day where-ever you be, as also the *Variation* of the Needle itself in that Place; for when you have set it to shew the *Hour*, if the *Needle* then lies *parallel* with the *Semicircle*, representing *one half* of the *Meridian*, it has then no *Variation*, but if it lies athwart with the *Meridian*, the *Angle* that it makes either to the *East* or *West* is the *Variation* of the Needle in that Place.

N. B. It matters not whether you put any more *Hour Lines* upon the Dial than are *useful in the Latitude where you are*; as for instance, at *London* you may omit the Hours after eight at Night till four in the Morning.

How naturally the *Hour Lines* may be drawn upon any Plane from the *Equinoctial Dial*, I shall here shew. Fix your *Stile* to your Dial Plane in its right Position by help of your *Quadrant*, i. e. by applying the Edge thereof to the *Stile*, and then the String cutting the Limb thereof in the Degrees of the *Latitude* of your Plane, because the *Top* of the *Stile* is *parallel* to the *Earth's Axis*; and be careful also that it stands at *right Angles* to the $\dagger$ *substilar Line*, whatever Dial it be; then cut a Slit quite thro' the *Equinoctial Dial* from the *North edge* to the *Center* along the 12 a-clock Line, just so wide as to receive

your

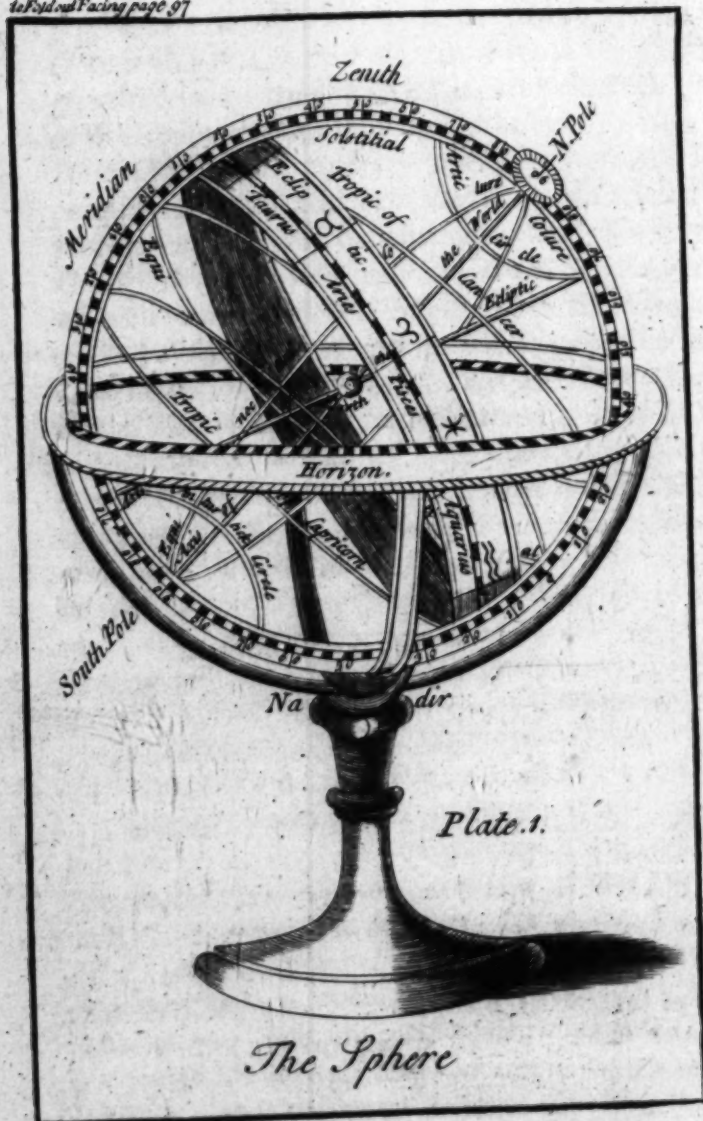
your Stile; put this Slit upon the Stile of your Dial, so that the *Equinoctial Dial* may stand at *right Angles* thereto, for then doth it lie parallel to the Plane of the *Equinoctial* itself: From that Point where the *Equinoctial Dial* toucheth the Stile, let fall a Perpendicular upon the *substilar Line*, this I call the *perpendicular height* of the Stile; take this in your Compasses, and set one Foot in the *substilar Line* where the *perpendicular height* of the Stile touched it, and sweep a Circle; to this Circle draw a *tangent Line* at *right Angles* to the *substilar Line*; Lastly, Put a Thread in the Center of the *Equinoctial Dial* (allowing for the Thickness of the Stile) and stretch it over the *Hour Lines*, and where the Thread toucheth the *Tangent Line* upon your Plane make Marks; and Lines drawn from the Center of your Dial to those Marks in the *Tangent Line* are the true *Hour Lines* upon your Dial: and this is a plain and ready way of drawing *Hour Lines* upon all Sorts of Planes.

A Review of the direct West Dial.

After what is said concerning it in Chap. VII. VIII.

This Dial as well as the *East Dial* is universal, which I thus explain; procure a Plate of Brass of what Size you please, and about the Thickness of a Shilling, well polished on both Sides, on which draw an *East Dial* on one Side and a *West Dial* on the other, so that the Center of the Circle PHDS, on one Side may exactly answer the Center of the Circle on the other Side; let a Circle circumscribe your *Dials*, and the upper Quadrant divided into 90 equal Parts or *Degrees*; let there be a Ring in a swivel to screw to the *Zenith* of the Place wherever you be, after the manner of a *Ring Dial*; then hanging it on your Finger, placing its Plane parallel to the Meridian of
the





Chap. XXII. *A Description of the Sphere.* 97

the Place (which may be done by help of a Magnetic Needle) it will shew you the true Hour of the Day, except it be exactly 12 a-clock, and then neither the *East* or *West* Side will shew the Hour, for the Shadow of the Stiles do then fall off both the Planes.

These Things I mention as Curiosities, shewing how by keeping the Axis of your Dial parallel with the Axis of the World, the Dial by that means is universal, for under the *Arctic Pole* the Hour-line will be *perpendicular* to the Horizon, and under the *Equinoctial* they will become *parallel*, or lie in the Plane of that great Circle. But if under the *Equinoctial* you lay the Dial flat down, so that the Circle PHDS may represent the Horizon of that Place, and placing 12 where 6 now stands, one where 5 is, &c. and 11 where 7 is, and 10 instead of 8, &c. to 6; this Dial will then represent a *Polar* or *Equinoctial* Dial, which ever you please to call it.

CHAP. XXII. *A DESCRIPTION of the SPHERE.* (See the Print.)

THERE are Ten eminent Circles upon the Sphere; Six of which are called *greater Circles*, and the other Four are called *lesser Circles*.

A *great Circle* of the Sphere is that whose Plane passeth through the Center of the Sphere, and divides the Sphere itself into two equal Parts.

A *lesser Circle* is that which lies parallel to a greater, as the *Tropicks* or *Polar Circles* do to the *Equinoctial*.

Or *lesser Circles* are such as do not divide the Sphere into two equal Parts.

The six greater Circles are the *Horizon*, the *Meridian*, the *Equinoctial*, the *Ecliptick*, the *Equinoctial Colure*, and the *Solstitial Colure*, and the four lesser Circles are the *Tropick of Cancer*, the *Tropick of Capricorn*, and the two *Polar Circles*. But,

First, *Of the Six great Circles.*

1. The *Horizon* is that *Circle* whereon the *Earth* and *Sky* seem to meet, and therefore when the *Sun*, *Moon*, and *Stars* come to the *East* thereof they are said to *rise*, and when they come to the *West* thereof they are said to *set*.

2. The *Meridian* is that *Circle* which is exactly in the *Middle* between the *East* and *West*, and always cuts the true *North* and *South* Points of the *Horizon*; its *Use* is to shew the *Time* of *Mid-day* and *Mid-night*; for when the *Sun* comes to the *South Point* of this *Circle* which is above the *Horizon*, it is *Noon*; and when to that *Point* of the *Circle* which is under the *Horizon*, then it is *Midnight*; and that *Point* in the *Meridian* which is exactly over your *Head*, is called the *Zenith*; and that under your *Feet* the *Nadir*.

3. The *Equinoctial Circle* is always distant from you as much as is the *Latitude* of the *Place* you are in, and is also equal to the *Height* of the *Pole* above your *Horizon*; its *Use* is to determine the *Time* of the *Day* or *Night*; for every 15 *Deg.* thereof is equal to one *Hour* in *Time*, and it always cuts the true *East* and *West* Points of the *Horizon*.

4. The *Ecliptick* is that *Circle* in which the *Sun* is said to move, and this *Circle* cuts the *Equinoctial* in the beginning of *Aries* and *Libra*, making an *Angle* therewith of 23 *Deg.* 29 *Min.* which *Angle* is equal to the *Sun's* greatest *Declination*; It is divided into
twelve

twelve equal Parts, called *Signs*, and character'd as in the *Figure* with α , β , γ , &c. and every *Sign* is divided into thirtyequal Parts called *Degrees*; so that

This, and every great Circle of the *Sphere* contains 360 *Degrees*.

N. B. In or near this Circle the *Eclipse* of the *Sun* and *Moon* are always found, from whence it takes its Name.

5. The *Equinoctial Colure* is a Circle that cuts the *Equinoctial* at right Angles in the beginning of *Aries* and *Libra*, and passes thro' the *Poles* of the *World*: This Circle determines the beginning of the *Spring*, and fall of the *Leaf*; for when the *Sun* comes here (which is on the 21st of *March*, and 22d of *September*) the *Days* and *Nights* are equal.

6. The *Solstitial Colure* is a Circle that cuts the *Equinoctial Colure* at right Angles in the *Poles* of the *World*, and when *Cancer* is upon the *Meridian*, this Circle is also upon the *Meridian* (as you may see by the *Sphere*.) when the *Sun* comes to this *Colure* (which is upon the 21st of *June*, and the 22d of *December*) he determines the longest and shortest *Days* to all the *Inhabitants* on the *North Side* the *Equinoctial*.

N. B. The above six Circles cut the *World* into two equal Parts.

Secondly, Of the Four lesser Circles of the *Sphere*.

1. The *Tropick of Cancer* is parallel to the *Equinoctial*, and distant from it 23 Deg. 29 Min. which is the *Sun's* greatest Declination Northward; here the *Ecliptick* and the *Solstitial Colure* meet in the very beginning of *Cancer*, making the longest Day to all the *Northern Inhabitants*.

2. The *Tropick of Capricorn* is, also parallel to the *Equinoctial*, but distant from it 23 Deg. 29 Min. towards the *South*, and is equal to the *Sun's greatest Declination*; here the *Ecliptick* and *Solstitial Colure* meet in the very beginning of the Sign *Capricorn*, making the *shortest Day* to all the *Northern Inhabitants*.

The Reason why these are called *lesser Circles* is, because they cut the *Sphere* (or *World*) into two unequal Parts.

LASTLY, The two *Polar Circles* are the same Distance from the *Poles*, that the *Tropicks* are from the *Equinoctial*, viz. 23 Deg. 29 Min. When the *Sun* enters *Cancer*, those that live under the *Arctic Circle* see him in their *Horizon* at *Midnight*, and when the *Sun* enters *Capricorn*, those that live under the *Antarctic Circle* see the *Sun* in their *Horizon* at *Midnight*.

The *Earth's Axis* is a Line supposed to pass from *Pole to Pole*, and through the *Earth's Center*; and *note*, it always represents the *Top*, or uppermost Part of the *Stile* in all *Dials*: and makes an *Angle* with the *Horizon* equal to the *Latitude* of your *Habitation*: and it always cuts the *Equinoctial* at *right Angles*, and the *Equinoctial* makes an *Angle* with the *Horizon* equal to the *Complement of the Latitude* of the *Place* where you live.

The *Earth* is fixed upon its *Axis* in the middle of the *Sphere* (or *World*) and in *Dialling* it is reckoned no more than a *Point*, because it is at so vast a Distance from the *Sun*.

N.B. The *Axis* of the *Ecliptick* is noted in the *Sphere*, but is of no manner of Use in *Dialling*.

CHAP. XXIII. Latin Mottos for Dials, with
their Meaning in English.

- 1 { *ALIIS inserviando consumor.*
Profit by my Loss.
- 2 *Ars longa Vita* Art is without End,
brevis. Life but a Span.
- 3 { *Avaritia bodie dominatur.*
You covet to-morrow.
- 4 *Aut Caesar aut nihil.* I shine or shroud.
- 5 *About your Business.
- 6 *Amat Lucem.* It loves the Light.
- 7 *Adveniet ille Dies.* The Day will come.
- 8 { *Abi, non moratur Hora, ambula in Luce.*
Begone, the Hour flies, walk in Light.
- 9 *Alias et idem.* Every where the same.
- 10 *Aspice fugimus.* Behold we fly.
A [or e] Cælo Veritas.
- 11 Truth the Daughter of Heaven.
- 12 *Agi. ad pœnitendum.* Forced to recant.
- 13 *Bulla est vita humana.* Life's a Bubble.
- 14 *Brevis Hominum vita.* Short is human Life.
- 15 Behold and be gone about your Business.
- 16 Consume not thy Time in Idleness.
- 17 *Cursum peregi.* I have finished my Course.
- 18 *Circumspicit omnia.* He beholds all Things.
- 19 { *Claritatem et splendorem solis indico.*
I shew by the Kindness and Splendor of the Sun.
- 20 { *Cum tempus non existit, tunc morior.*
When Time ceases to exist, I shall be forgotten.

* On the General Post-Office.

- 21 { *Certitudinem acquirit eundo.*
 { Its Progress confirms its Certainty.
- 22 *Carpe diem.* This is the Day.
- 23 { *Carpe diem quam minimum credula postero.*
 { None can tell what will happen to-morrow.
- 24 { *Cui solem ante ferum?*
 { What can be compared with the Sun?
- 25 *Cito pede labitur ætas.* Time passes swiftly away.
- 26 *Cito pede præterit ætas.* Time swiftly flies away.
- 27 *Concito gradu.* My Flight is rapid.
- 28 *Confidera te.* Know thyself.
- 29 *Certa Ratio.* An account must be given.
- 30 *Cædimur merito.* We suffer deservedly.
- 31 { *Deus adest laborantibus.*
 { Heaven favours the Diligent.
- 32 { *Disce dies numerare tuos.*
 { Learn to value your Time.
- 33 { *Disce bene vivere & mori.*
 { Live and die happy.
- 34 *Dies diem trudit.* A Day may ruin thee.
- 35 *Dum spectas fugio.* I fly while you behold me.
- 36 { *Dona præsentis cape lætus.*
 { Enjoy the present Hour.
- 37 { *Discite justitiam moniti.**
 { Learn to be wise in Time.
- 38 { *Dum spectas fugit hora.*
 { The Hour flies while you are gazing.
- 39 *Dum fugio numeras.* I fly while you number.
- 40 *Disce mori mundo.* Die to the World.
- 41 { *Dum fugit umbra, quiesco.*
 { The Shadow moves tho' I am at Rest.
- 42 { *Durabat splendor solis.*
 { The Light of the Sun shall endure.

- 43 { *Dona præsentis rape lætus.*
Chearfully accept of Things present.
- 44 *Depressa resurgo.* I set to rise.
- 45 { *Dare quam accipere.*
It is more blessed to give than to receive.
- 46 { *Dum videam satis est.*
If I but see it is sufficient.
- 47 { *Dum spectas splendit.*
Whilst thou art looking he shines.
- 48 *Disponit tempus dies.* Days make Years.
- 49 { *Dies affert multa.*
Sufficient to the Day is the Evil thereof.
- 50 { *Disce tuos numerare dies.*
Learn to number thy Days.
- 51 { * *En supra vita fugax.*
† *En infra certa mors.*
A Life on Flight's soon out of Sight.
- 52 { *Ex hoc momento pendet æternitas.*
On the present Moment depends Eternity.
- 53 { *Eheu fugaces labuntur anni !*
Where is last Year flown !
- 54 { *Ecce ut hora sic fugit vita.*
Life flies like the Hour.
- 55 *Ecce hora.* Now or never.
- 56 *Et nobis et vobis.* To us and you.
- 57 { *Eternam tibi semper adesse puta.*
You are on the Brink of Eternity.
- 58 { *Ecce nunc tempus acceptabile festinè salvare.*
Now is the accepted Time, now is the Day of Salvation.
- 59 { ** *Edwardus fovet ut sol.*
Edward beneficent as the Sun.

* At the Top { of one Face of a Dial on *St. Mary Overy's* Church,

† At the Bottom { *Southwark*, which hangs over the Burial-Ground.

** On *Christ's* Hospital, founded by *EDWARD* the VIth.

304 Latin Mottos for Dials, &c. Chap. XXIII.

- 60 *Extricas nihil.* Effect nothing.
- 61 *Exhibe fidem vocis.* Perform your Promise.
- 62 *Festina lente.* { Observe my Motion.
Do nothing hastily.
- 63 { *Fortuna urbes amplissimas evertit.*
No Exemption from my Influence.
- 64 { *Fugio fuge.*
Be gone about your Business.
I stay for no Man.
- 65 *Festinat suprema.* The last Hour approaches.
- 66 *Fugit dies (vel hora)* The Day flies.
- 67 *Fugit ætas avara.*
- 68 { *Fugit hora sine mora.*
Time passes away without Delay.
- 69 *Frustra me extinguis.* To stop me is impossible.
- 70 *Finem vitæ specta.* Such is Life.
- 71 { *Fumus et umbra sumus.***
Smoke and Shadow are Emblems of Life.
- 72 { *Fugax est ætas.*
Life is of short Continuance.
- 73 { *Fugit irreparabile tempus.*
Time when past is irreparable.
- 74 { *Grata superveniet hora.*
May it be a welcome Hour.
- 75 *Grata superveniet.* May it be welcome.
{ *Grata superveniet quæ non sperabitur.*
- 76 { The less expected the more pleasing.
- 77 { **Hinc vivere disce.* } Rising portends setting.
{ *† Illinc disce mori.* }
- 78 *Hora quasi umbra.* Man is but a Shadow.
- 79 { *Homo fugit rapide lethumq; invadit inermes.*
The Hours glide swiftly, and the unguarded are easily surprised.

** On a Dial on a Chimney.

• At the Top

† At the Bottom

{ of another Face of the Dial on St. Mary Over-
ry's Church, Southwark; which hangs over the
Burial Ground.

- 80 *Hora pars vitæ.* Every Hour shortens life.
- 81 { *Horam quam petis redimite.*
Redeem the Time.
- 82 { *Haud mora carpe diem.*
Seize the present Opportunity.
- 83 *Hoc tuum est.* The present only is thine.
- 84 *Heu! quærimus umbram.* We pursue shadows.
- 85 *Horam vitam imminuit.* Every Hour shortens life.
- 86 *Hoc age.* Remember.
- 87 *Hodie mihi cras tibi.* Each in his Turn.
- 88 *Ita vita.* Such is life.
- 89 *I bide my Time.* I stay for no Man.
- 90 *Immotum in motu.* Ever the same.
- 91 { *Inter Cæsarem & Galbam*
Sol ministrat umbram.
The Sun is alike beneficent to all.
- 92 { *Interpres fidus solis.*
I interpret faithfully the Sun.
- 93 *Indico utere.* Improve by my Admonition.
- 94 *In singulas horas.* Every Moment.
- 95 *Ingravantibus annis.* Our Years multiply.
- 96 *Labor ipse voluptas.* I labour for your Pleasure.
- 97 { *Lex Dei lux Diei.*
The Law of God is as clear as the Light.
- 98 *Let your Light so shine that Men may see your good Works.*
- 99 { *Lente suscipe cito perfice.*
Set out at Leisure, proceed with Haste.
- 100 *Luce laborandum.* Walk whilst it is light.
- 101 *Luce lucit.* He shines in the Light.
- 102 *Lux post umbram.* After Darkness Light.
- 103 *Lux venit ab alto.* Light comes from above.
- 104 { *Leges luce clariores.*
Thy Commandments enlighten the Eyes.
- [104] *Luceo et lateo.* I shine and set.

106 Latin Mottos for Dials, &c. Chap. XXIII.

- 105 *Lux umbra Dei* { God is Light.
Light is God's Shadow.
- 106 Look forward.
- 107 *Ludimus leve.* We trifle.
- 108 *Lues culpam spiritu.* Your Life shall pay for it.
- 109 { *Mora trahit periculum.*
Delay is the Parent of Danger.
- 110 { *Me ortum vides forsitan non occasum.*
You have seen me rise, but may not see me set.
- 111 *Maneo nemini.* I stay for no Man.
- 112 { *Memor esto brevis ævi.*
Remember the Shortness of Life.
- 113 Mind your Business.
- 114 *Monstrat in silentio.* Silent Instruction.
- 115 *Mors ultima pœna est.* Death closes the Scene.
- 116 *Mors omnia vincit.* Death conquers all.
- 117 { *Mors de die accelerat.*
Every Day brings Death nearer.
- 118 { *Mors nobis quotidie imminet.*
This Day may be your last.
- 119 { *Memor esto quod morieris?*
Can you forget you are mortal?
- 120 *Mors meta laborum.* Death terminates Labour.
- 121 *Mors iter ad vitam.* To die is to live.
- 122 *Moriendo vivo.* I live and die daily.
- 123 *Metam properamus ad unam.* All must die.
- 124 *Mortalia cogita.* Remember thou art mortal.
- 125 { *Me lumen vos umbra regit.*
Light directs me, and you a Shadow.
- 126 *Mors omnia sternit.* Death conquers all.
- 127 *Me nutrit Apollo.* Apollo is my Teacher.
- 128 { **Mentiri non est meum.*
Lying does not belong to me.

* On a Dial facing Billingsgate, where the Dealers in Coals assemble daily.

129 Man's but a Shadow.

130 { *Nemo sine crimine vivit.*
The brightest Day has its Shades.

131 { *Nil dat quod non habet.*
Of nothing, nothing can be produced.

132 { *Non semper erunt Saturnalia.*
Take Time by the Forelock.

133 { *Non nobis nati sumus.*
We are not made for ourselves.

134 *Non sine lumine.* Not without Light.

135 *Nosce teipsum.* Know thyself.

136 *Nulla dies sine linea.* Improve every Day.

137 { *Noli confidere noctem.*
You are not sure of seeing Night.

138 { *Non progredi et regredi.*
Every Stop lessens the Progress.

139 { *Nos flendo ducimus boras.*
Life is a melancholy Tale.

140 *Nascimur & morimur.* Born and dead.

141 *Non moror.* I never stop.

142 *Non redibo.* Never to return.

143 { *Nec sol in summo manet.*
The Sun has his Vicissitudes.

144 { *Nil boni hodie diem perdidit.*
What good Actions have you performed to-day?

145 *Nec metuendo viris.* Indifferent to the Wise.

146 { *Neque lux sine umbra.*
No Light without a Shadow.

147 *Nocet umbra nocenti.*

148 *Non semper clarum.* Not always intelligible.

149 *Nos ut umbra.* We resemble the Shadow.

150 *Nescitis boram.* Ye know not the Hour.

151 *Non vetuit mori.* No flying from Death.

152 *Nostra latet.* We know not our End.

108 Latin Mottos *from* Dials, &c. Chap. XXIII.

- 153 { *Non memet extinguo.*
My Term is not my own Decree.
- 154 { *Non quantum, sed quo modo.*
The Manner, not the Matter.
- 155 { *Non aliter pario species quam futilis umbra.*
My Emblem is a Shadow.
- 156 *Nihil velocius annis.* Nothing faster than Time.
- 157 *Non in tenebris.* Not in Darkness.
- 158 *Non rego nisi negar.* As I am directed I direct.
- 159 { *Noli imputare mihi.*
Place them not to my Account.
- 160 *Nocendum nulli.* Injure no Man.
- 161 *Noli irascaris.* Avoid Anger.
- 162 { *Omnem crede diem tibi diluxisse supremum.*
Believe every Day to be the last.
- 163 { *Omnia false metit tempus.*
Nothing can resist the Scythe of Time.
- 164 *Orimur et morimur.* We rise and set.
- 165 { *Omnia fallace que mentes oppressa fuge.*
Delusive Shadow, so speedy in thy Flight.
- 166 *Otium fuge.* Fly Idleness.
- 167 { *Omnia fert etas.*
Time brings all Things to pass.
- 168 { **Oriens sol. adornatur.*
When Sol adorns the East.
- 169 { *Pereunt et imputantur.*
The Hours vanish, yet are recorded.
- 170 *Pax optima rerum.* Light is the Parent of Peace.
- 171 { *Post voluptatem misericordia.*
Pleasure is the Parent of Pain.
- 171 { *Night treads upon the Heels of Day.*

* An East Dial.

† Upon a Dial at a Lark, or Hospital for those who have the *feul* *Dysast.*

172 Peace, Love and Unity, thro' Time to Eternity.

173 Prize Time.

174 { Pulvis et umbra sumus.

{ Life passes like the Shadow.

175 Proba veritatem mei. Try me.

176 { Publica privatis secernite sacra profanis.

{ Be always discreet.

177 { Plura labori dulcibus quædam otis.

{ Repose after Labour is sweet.

178 Post tenebras lucem. After Darkness Light.

179 { Post tenebras spero lucem.

{ After Darkness I hope for Light.

180 { Præstant eterna caducis.

{ Eternity alone merits our Attention.

181 { Procrastinatio est odiosa.

{ Delays are dangerous.

182 { Post est occasio calva.

{ Do not omit the present Opportunity.

183 { Phœbus instat revivisco.

{ I revive like The Sun.

184 { Phœbus recitat quæ vulcanus excussit.

{ Proxima non nostræ est.

185 { The next is not in our Power.

186 { Qualis vita, such is it.

{ A virtuous Life, a happy Eternity.

187 { Quid tibi fieri non vis, alteri ne feceris.

{ Do as you would willingly be done by.

188 { Qua redit nescitis horam.

{ Ye know not the Hour.

189 { Quid celerius tempore?

{ What is swifter than Time?

190 { Quanti quæras ne perdas.

{ Secure it whilst in your Power.

Quid

110 Latin Mottos for Dials, &c. Chap. XXIII.

- 191 { *Quid cunctaris nisi occupas fugit.*
Seize the flying Hour.
- 192 { *Quod petis umbra est.*
You pursue a Shadow.
- 193 { *Quod vides non diu.*
The Things seen are temporal.
- 194 *Qua pota lucit.* Exert your Talents.
- 195 { *Quid optas quod habes.*
Ridiculous! to wish and have.
- 196 { *Quasi umbra transit vita.*
Life passes like the Shadow.
- 197 { **Quid stans? transit est hora.*
All is temporary, and passeth like the Hour.
- 198 *Quid multa?* One Thing is necessary.
- 199 *Quanta res!* How important!
- 200 *Redime tempus.* Redeem the Time.
- 201 { *Redime tempus, nil perpetuum.*
Redeem the Time, it will soon be gone.
- 202 { *Redime tempus, vivitur ex-rapto.*
Redeem the Time, the Tenure is uncertain.
- 203 *Revocabile tempus.* Recall the Time.
- 204 *Resurga.* Awake to Life.
- 205 † *Resurgam.* I shall rise again.
- 206 *Ruit hora.* The Hour flies.
- 207 Remember.
- 208 *Rus in urbe.* The Country in the City.
- 209 *Religionem cole.* Honour Religion.
- 210 *Sic vita.* Such is Life.
- 211 { *Sic transit gloria mundi.*
So marches the God of Day.
- 212 *Sine lumine inane.* Not without Light.
- 213 *Sic præterit ætas.* Life flies swiftly.

* On the Church Porch of Calbeck in Cumberland.

† Alluding to the setting Sun.

- 214 *Sic hominis vita.* Such is the Life of Man.
 215 *Semper in motu.* Ever in Motion.
 216 { **Sol lucet charitas extendit omnibus.*
 { Charity, like the Sun, is beneficent to all.
 217 So flies Life away.
 218 *Sensim sine sensu.* { Insensibly.
 { I move insensibly.
 219 *Senescimus effugit ætas.* Old Age approacheth.
 220 *Semper paratum.* Be always prepared.
 221 *Subserviens vehicula lucis.*
 { *Sic tibi tempus erit.*
 222 { Your Time is approaching.
 { *Suprema hæc multis forsân tibi.*
 223 { The last to many, possibly to you.
 { *Suprema multis hora forsân tibi.*
 224 { The last Hour to many, possibly to you.
 225 † *Sicut flos.* Like a Flower.
 226 { *Sol ministrat umbram.*
 { The Sun causes the Shadow.
 227 † *Sumus fumus.* We vanish like Smoke.
 228 So flies Life away.
 229 { *Sol gloria spheræ.*
 { The Sun gives a Lustre to the Universe.
 230 { *Sic fiti lætantur læres!*
 { How delightful the extended Prospect!
 { *Sic imus ad atria lucis,*
 231 { *Aut umbras erebi.*
 { Thus we pass on to Happiness or Misery.
 232 *Sic subducimur.* Thus our Lives terminate.
 233 { *Sol splendit omnibus.*
 { The Sun shines on all.

* At a Charity-School.

† In a Garden.

‡ On a Chimney.

112 Latin Mottos for Dials, &c. Chap. XXIII.

- [233] { *Si Deus nobiscum quis contra nos.*
My God and all Things.
{ *Salve domine Anglorum.*
- 234 { Hail Lord of Britain.
{ *Spectator fastidiosus sibi molestus.*
- 235 { Envious Spectator, be thy own Tormentor.
- 236 *Semel elapsum.* Once elapsed.
- 237 { *Tempus ad lucem ducit veritatem.*
Time brings Truth to Light.
- 238 { *Tempus obit, mors venit.*
Time dies, Death reigns.
- 239 *Tempus fugit.* Time flies.
- 240 { *Tempus vitæ monitor.*
Time is a Memento to Life.
- 241 { *Tenere non potes nec perdere.*
Impossible to be kept or lost.
- 242 { *Tempus me. velocius a volans redimite.*
The Rapidity of Time augments its Value.
- 243 { *Transit hora sine mora.*
'Tis impossible to stop the fleeting Hour.
- 244 { *Tempus rerum imperator.*
Time commands all Things.
- 245 *Tempus labitur.* Time steals away.
- 246 *Tarde sed certe.* Slow but sure.
- 247 Take Time by the Forelock.
- 248 Time flies.
- 249 { *Tempus edax rerum.*
Time brings all Things to an End.
- 250 { *Tenere non potes, perdere potes.*
You may waste, but cannot stop me.
- 251 True as the Dial to the Sun.
- 252 * *Tanquam fumus.* { Like Smoke.
Life vanishes like Smoke.

* On a Chimney.

253 *Tempori*

- 253 *Tempori pare.* Yield to the Times.
 254 { *Tempus celerrime aufugit.*
 { Time passes swiftly away.
 255 { *Tempus omnia revelat.*
 { Time reveals all Things.
 256 { *Tempore fiunt omnia.*
 { Time finishes all Things.
 257 { *Tempus vitæ monitor.*
 { Time is the Monitor of Life.
 258 *Tempus breve est.* Life is short.
 259 Take up the Cross and follow me.*
 260 Time and Tide stay for no Man.†
 261 Time is precious.
 262 { *Tempus fugit, mors venit.* [ing.
 { Time's on the Wing, and Death's approach-
 263 { *Tot horæ quot vices.*
 { Every Hour has its Changes.
 264 *Truditur dies die.*** One Day succeeds another.
 265 { *Tempora mutantur & nos.*
 { All Things fluctuate.
 266 *Trepide.* In a Hurry.
 267 { *Umbra Dei.*
 { The Workmanship of the great Architect.
 268 { *Ut umbra sic vita.*
 { Life is fleeting as the Shadow.
 269 *Venio ut fur.* I steal imperceptibly upon you.
 270 { *Vigilate & orate, tempus fugit.*
 { Watch and pray, Time steals away.
 271 *Via vitæ.* Life's Road.
 272 { *Vita nostra est instar commædiæ.*
 { Life often changes Scenes.

* On the Face of a Dial, on which is painted St. Andrew and his Cross, on the South Side of St. Andrew's Church, in Holborn.

† At the Steel Yard, facing the Thames.

** HORACE.

- 114 Latin Mottos *for Dial*, &c. Chap.XXIII.
- 273 { *Veritas temporis filia.*
Time is the Father of Truth.
- 274 { *Vehimur properantibus horis*
ad cælum aut erebum.
The fleeting Hours waft us to Happinefs or Mifery.
- 275 *Vigilate.* Be vigilant.
- 276 *Vestra latet.* Your Fate is uncertain.
- 277 { *Vanescit & iterum apparet.*
It vanishes and appears.
- 278 *Verum soli.* True to the Sun.
- 279 { *Umbra videt umbram, vive bodie.*
One Shadow gazeth at another.
- 280 { *Una dabit quod negat altera.*
What is denied by one may be supplied by another.
- 281 { *Vigor ætatis fluit ut flos veris.*
Life in its greatest Vigour is altogether Vanity.
- 282 { *Utere præfenti, memor ultimæ.*
If you remember the laft, you'll improve the prefent.
- 283 { *Umbra transitus est tempus nostrum.*
Our Life refembles the Shadow that paffeth away.
- 284 { *Vive memor quam fis ævi brevis.*
Life how fhort ! Eternity how long !
- 285 { *Ventus quo vult fpirat.**
The Wind bloweth where it lifteth.
- 286 *Vita tranfit.* Life paffeth away.
- 287 { *Verus fum temporis index.*
I fhew the Time faithfully.
- 288 { *Vivite, ait fugio.†*
Live, it fays, I am on the Wing.
- 289 *Volucris curfu.* With winged Speed.
- 290 Welcome Chapmen.**

* On a Wind Dial.

† B. Atterbury, at Bromley in Kent.

** On a Dial in a Market Place.

Chap. XXIII. Latin Mottos for Dials, &c. 119

291 Work to-day, and play to-morrow.

292 Watch, for you know not the Hour.

293 Watch.

294 Ζωὴ ἀτμὴ σκίη. Life's the Spectator of a Shadow.

*Upon the Sun-Dial on the High-Church Wall of
GLASGOW.* 295

Our Life's a flying Shadow, God's the Pole;
The Index pointing at him is our Soul;
Death's the Horizon, when our Sun is set,
Which will through *Christ* a Resurrection get.

Written on a Sun-Dial in a Circle. 296

Sic petit oceanum Phæbus, sic vita sepulchrum,

Dum sensim tacita volvitur hora rota :

Secula sic fugient, sic lux, sic umbra, theatrum

Donec stelligerum clauferit una dies.

Afterwards turned into English :

Thus steal the silent Hours away,
The Sun thus hastes to reach the Sea,
And Men to mingle with their Clay. }
Thus Light and Shade divide the Year, }
'Till the last great Day appear }
To shut the starry Theatre.

ANOTHER.

297 So slide the Hours, so wears the Day,
These Moments measure Life away,
With all its Trains, of Hope and Fear ;
'Till shifting Scenes of Shade and Light
Rise to eternal Day, or sink in endless Night,
Where all is Joy, or all Despair.

*On a Cieling Dial, usually called a Spot Dial, made
at a western Window at Theobald's.*

- 298 Little Sun upon the Cieling,
Ever moving, ever stealing
Moments, Minutes, Hours away,
May no Shade forbid thy shining,
While the heav'nly Sun declining
Calls us to improve the Day.

Another for a Spot Dial.

- 299 Shining Spot, but ever sliding!
Brightest Hours have no abiding:
Use the golden Moments well;
Life is wasting,
Death is hastening,
Death consigns to Heav'n or Hell.

A N O T H E R.

- 300 See the little Day-Star moving;
Life and Time are worth improving:
Seize the Moments while they stay,
Seize and use them,
Lest you lose them,
And lament the wasted Day.

A N O T H E R.

- 301 This plainly shews to foolish Man,
That his whole Life is but a Span.

CHAP. XXIV. *A new Table of the Elevation of the Pole, and Difference of Meridians from London.*

A *New and Correct Alphabetical Table of the most eminent Cities, Towns, &c. in the World; shewing at each Place the Elevation of the Pole, and the Difference of their Meridian from London.*

☞ The *Elevation of the Pole* signifies the same Thing as the *Latitude of the Place*; and the *Difference of the Meridian*, the same as the *Longitude of the Place*.

Note,

D	} signifies {	Degrees		E	} signifies {	East	} Longitude	
H		Hours		W		West		
M		Minutes		N		North		} Latitude.
				S		South		

An Explanation of the following Table.

The *Names* of the *Places* stand in an *alphabetical Order*, and those *Names* are always followed by *One* or *Two* more in the same *Line* or *Article*. Where there is but *One Name* following *that* of the *Place*, it signifies what *Kingdom* or *Part of the World* it is situated in; as *Athens*, *Greece*, signifies that *Athens* is in *Greece*: But where there are *Two Names* following the *Name of the Place*, the *First* signifies the *Province* or *Division*, and the *Second* the *Kingdom* or *Part of the World*, as *Aix la Chapelle*, *Westphalia*, *Germany*, signifies that *Aix la Chapelle* is in *Westphalia*, which is a *Province* of *Germany*, and so of all the rest.

N. B. The *Table of the principal Cities and Towns in England, Scotland, Ireland, and Wales*, is on *Page 14, &c.*

118 *A new Table of the Elevation of the*

	Latit.		Dif. M.	
	D.	M.	H.	M.
A.				
<i>Adrianople, Turkey, Europe</i>	43	18 N	1	50 E
<i>Agra, a Capital in the Mogul's Empire</i>	29	0 N	5	38 E
<i>Aix, Provence, France</i>	43	4 N	0	23 E
<i>Aix la Chapelle, Westphalia, Germany</i>	50	48 N	0	28 E
<i>Aleppo, Syria, Asia</i>	37	0 N	2	45 E
<i>Alexandria, Egypt, Africa</i>	31	25 N	2	3 E
<i>Alexandretta, Syria, Asia</i>	37	10 N	2	31 E
<i>Algiers, Barbary, Africa</i>	36	20 N	0	9 E
<i>Alicant, Valencia, Spain</i>	37	45 N	0	1 E
<i>Amsterdam, Holland</i>	52	29 N	0	20 E
<i>Antibes, Provence, France</i>	43	15 N	0	33 E
<i>Antwerp, Brabant</i>	51	16 N	0	17 E
<i>Archangel, Russia</i>	64	30 N	2	41 E
<i>Arica, Peru, South America</i>	18	50 S	4	59 W
<i>Asracan, near the Caspian Sea, Muscovy</i>	46	50 N	3	26 E
<i>Athens, Greece</i>	37	25 N	1	35 E
<i>Augsburg, Suabia, Germany</i>	47	55 N	0	43 E
B.				
<i>Babylon, Chaldea</i>	34	30 N	3	14 E
<i>Bagdat, Mesopotamia, Asia</i>	33	0 N	3	2 E
<i>Baldovia, Chili, South America</i>	40	0 S	5	12 W
<i>Barbadoes, West-Indies</i>	13	10 N	3	59 W
<i>Barcelona, Catalonia, Spain</i>	41	10 N	0	8 E
<i>Batavia, Java, East-Indies</i>	6	5 S	7	6 E
<i>Bayonne, Gascony, France</i>	43	30 N	0	5 W
<i>Belgrade, Servia</i>	45	0 N	1	13 E
<i>Belvedere, Naples, Italy</i>	39	35 N	1	6 E
<i>Benevento, Spain</i>	41	55 N	0	21 W
<i>Beneventum, Naples, Italy</i>	41	13 N	1	2 E
<i>Bengal, India</i>	21	0 N	5	12 E
<i>Bergen, Norway</i>	60	0 N	0	22 E
<i>Berlin, Germany</i>	52	10 N	0	52 E
<i>Bern, Switzerland</i>	47	0 N	0	31 E
<i>Bilboa, Biscay, Spain</i>	43	10 N	0	9 E
<i>Bologna, or Boulogne, Italy</i>	44	20 N	0	48 E
<i>Bonn, Lower Rhine, Germany</i>	50	30 N	0	30 E
<i>Boisleduc, Brabant, Flanders</i>	51	30 N	0	20 E
<i>Boston, New-England</i>	42	10 N	4	28 W
<i>Bourdeaux, Guienne, France</i>	44	55 N	0	3 E
<i>Bourges, Orleans, France</i>	46	54 N	0	10 E
<i>Brandenburg, Prussia, Germany</i>	52	10 N	0	50 E
<i>Brest, Bretagne, France</i>	48	34 N	0	18 E
<i>Breda, Spanish Provinces</i>	51	30 N	0	17 E
<i>Breslaw, Bohemia, Germany</i>	51	5 N	1	6 E
<i>Brill, Holland</i>	51	55 N	0	25 E
<i>Brindisi, Naples, Italy</i>	40	48 N	1	13 E
<i>Brunswick, Germany</i>	51	55 N	0	46 E

Bruges,

Pole, and Difference of Meridians.

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	Latit.		Diff. Me.	
	D.	M.	H.	M.
<i>Bruges</i> , Flanders	51	15 N	0	12 E
<i>Brussels</i> , Flanders	50	48 N	0	16 E
<i>Buda</i> , Lower Hungary	47	0 N	1	8 E
C.				
<i>Cadiz</i> , Andalusia, Spain	37	5 N	0	23 W
<i>Caen</i> , Normandy, France	49	5 N	0	22 W
<i>Cagliari</i> , Sardinia, Mediterranean	39	10 N	0	38 E
<i>Cairo</i> , Egypt, Africa	30	10 N	2	6 E
<i>Calais</i> , France	51	0 N	0	8 E
<i>Calecute</i> , East-Indies	11	0 N	4	59 E
<i>Cambray</i> , France	50	10 N	0	13 E
<i>Candia</i> , in Candia-Island	34	55 N	1	39 E
<i>Candea</i> , Ceylon, East-Indies	7	30 N	5	22 E
<i>Cape of Good Hope</i>	34	25 S	1	6 E
<i>Cartagena</i> , Spanish West-Indies				
<i>Cartagena</i> , Murcia, Spain	37	0 N	0	2 E
<i>Cartbage</i> , Barbary, Africa	35	0 N	0	44 E
<i>Casal</i> , Milan, Italy	45	5 N	0	34 E
<i>Catanea</i> , Sicily	37	20 N	1	1 E
<i>Ceuta</i> , Africa	35	50 N	0	23 W
<i>Charles-Town</i> , in Carolina	32	30 N	5	24 W
<i>Christianstad</i> , Gothland, Sweden	56	35 N	0	58 E
<i>Clermont</i> , Lionois, France	45	40 N	0	13 E
<i>Cleves</i> , Westphalia, Germany	51	40 N	0	25 E
<i>Cochin</i> , Malabar, Asia	10	0 N	5	1 E
<i>Cochin-China</i> , East-Indies, Asia	13	0 N	7	8 E
<i>Cologne</i> , Germany	50	40 N	0	29 E
<i>Constantinople</i> , Romania, Turkey	41	6 N	1	59 E
<i>Copenhagen</i> , Zealand, Denmark	55	40 N	0	50 E
<i>Corinth</i> , Morea, Turkey	38	0 N	1	30 E
<i>Cracow</i> , Poland	50	15 N	1	23 E
<i>Cremona</i> , Milan, Italy	45	10 N	0	42 E
<i>Cusco</i> , Peru, South America	12	20 S	4	48 W
<i>Cyprus Island</i> , Levant	35	0 N	2	16 E
D.				
<i>Dantzick</i> , Poland	54	25 N	1	18 E
<i>Darmstadt</i> , Upper Rhine, Germany	49	30 N	0	37 E
<i>Delft</i> , Holland	52	10 N	0	17 E
<i>Derbent</i> , near the Caspian Sea	42	0 N	3	20 E
<i>Deventer</i> , United Provinces	51	56 N	0	24 E
<i>Deux Ponts</i> , Upper Rhine, Germany	49	10 N	0	29 E
<i>Doway</i> , Flanders	50	12 N	0	14 E
<i>Dresden</i> , Saxony, Germany	51	6 N	0	55 E
<i>Drontheim</i> , Norway	63	0 N	3	41 E
<i>Dunkirk</i> , France	51	7 N	0	10 E
<i>Durazzo</i> , Albania, Turkey	40	40 N	1	11 E

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	E.	Latit.		Dy. Mo.
		D.	M.	H. M.
<i>Elbing, Poland</i>		54	20 N	1 22 E
<i>Embsen, Westphalia, Germany</i>		53	10 N	0 29 E
<i>Ephesus, Natolia, Asia</i>		37	50 N	1 50 E
	F.			
<i>Ferrara, Italy</i>		44	45 N	0 49 E
<i>Fez, Barbary, Africa</i>		33	15 N	0 24 W
<i>Finale, Genoa, Italy</i>		44	10 N	0 34 E
<i>Florence, Tuscany, Italy</i>		43	40 N	0 47 E
<i>Fort St. George, East-Indies</i>		13	0 N	5 20 E
<i>Frankfort on the Oder, Germany</i>		52	28 N	0 58 E
<i>Frankfort on the Main, Germany</i>		49	45 N	0 39 E
<i>Frieberg, Suabia, Germany</i>		47	50 N	0 33 E
<i>Furnes, Flanders</i>		51	15 N	0 11 E
	G.			
<i>Gallipoli, Romania, Turkey</i>		40	55 N	1 53 E
<i>Gelders, Gelderland</i>		51	15 N	0 26 E
<i>Geneva, Savoy, Italy</i>		46	15 N	0 25 E
<i>Genoa, Italy</i>		44	25 N	0 37 E
<i>Ghent, Flanders</i>		51	6 N	0 14 E
<i>Gibraltar, Andalusia, Spain</i>		35	30 N	0 19 E
<i>Glatz, Bohemia, Germany</i>		50	30 N	1 7 E
<i>Goa, East-Indies</i>		15	22 N	4 58 E
<i>Gombroon, Persian Gulf</i>		7	10 N	3 44 E
<i>Gottenburgh, Sweden</i>		57	30 N	0 48 E
<i>Granada, Granada, Spain</i>		36	20 N	0 11 E
<i>Graveling, Flanders</i>		51	4 N	0 10 E
<i>Grenoble, Dauphine, France</i>		45	10 N	0 23 E
<i>Grodno, Lithuania, Poland</i>		53	25 N	1 40 E
<i>Groeningen, Holland</i>		53	5 N	0 23 E
	H.			
<i>Hague, Holland</i>		52	10 N	0 16 E
<i>Hall, Suabia, Germany</i>		49	6 N	0 41 E
<i>Hamburg, Denmark</i>		53	30 N	0 40 E
<i>Hanaw, Upper Rhine, Germany</i>		50	3 N	0 41 E
<i>Hanover, Saxony, Germany</i>		52	16 N	0 36 E
<i>Harlem, Holland</i>		52	25 N	0 17 E
<i>Heidelberg, Lower Rhine, Germany</i>		49	12 N	0 35 E
<i>Helmstat, Saxony, Germany</i>		51	52 N	0 49 E
<i>Helst, Flanders</i>		51	20 N	0 19 E
	I.			
<i>James Town, Virginia, North America</i>		37	10 N	5 0 W
<i>Jerusalem, Palestine, Asia</i>		32	44 N	2 21 E
<i>Ingolstat, Bavaria, Germany</i>		48	32 N	0 52 E
<i>Ispahan, Ancient Persia, Asia</i>		33	0 N	3 33 E
<i>Julliers, Westphalia, Germany</i>		50	20 N	0 27 E
	K.			
<i>Kaminatek, Podolia, Poland</i>		49	20 N	1 38 E
				<i>Kargapol,</i>

	Latit.		Dif. Me.	
	D.	M.	H.	M.
<i>Kargapol</i> , Russia	61	30 N	2	49 E
<i>Kexholm</i> , Finland, Sweden	61	20 N	2	4 E
<i>Konigsburg</i> , Prussia, Poland	54	55 N	1	29 E
<i>Konizeck</i> or <i>Konioz</i> , Poland	54	15 N	1	15 E
L.				
<i>Landau</i> , Suabia, Germany	48	50 N	0	33 E
<i>Laodicea</i> , Natolia, Asia	38	10 N	1	58 E
<i>Larissa</i> , Thessaly, Turkey in Europe	39	30 N	1	29 E
<i>Larta</i> , Bpirus, Greece. now Turkey	39	0 N	1	17 E
<i>Lauenburg</i> , Saxony, Germany	53	20 N	0	43 E
<i>Legorn</i> or <i>Leghorn</i> , Tuscany, Italy	43	40 N	0	45 E
<i>Lepanto</i> , Achaia, Turkey	38	30 N	1	23 E
<i>Lerida</i> , Catalonia, Spain	41	15 N	0	3 E
<i>Leutwarden</i> , West Friesland, Holland	53	0 N	0	26 E
<i>Leyden</i> , Holland	52	10 N	0	14 E
<i>Leipsick</i> , Germany	50	50 N	0	51 E
<i>Leige</i> , Spanish Provinces	50	25 N	0	22 E
<i>Lima</i> , Peru, South America	11	30 S	5	15 W
<i>Lisse</i> , Flanders	50	40 N	0	11 E
<i>Lisbon</i> , Portugal	38	45 N	0	33 W
<i>Liorn</i> , see <i>Leghorn</i>				
L O N D O N , Metropolis of England	51	32 N	0	0
<i>Loratto</i> , Tuscany, Italy	43	36 N	0	59 E
<i>Louvain</i> , Spanish Provinces	50	40 N	0	19 E
<i>Lubeck</i> , Holstein, Denmark	54	10 N	0	45 E
<i>Lucca</i> , Tuscany, Italy	43	50 N	0	44 E
<i>Lunden</i> , Gothland, Sweden	55	30 N	0	54 E
<i>Luxemburg</i> , Saxony, Germany	53	10 N	0	43 E
<i>Luxemburg</i> , France	49	20 N	0	25 E
<i>Lions</i> , Lenois, France	45	40 N	0	19 E
M.				
<i>Madagascar</i> , Africa	19	29 S	2	56 E
<i>Madrid</i> , New Castile, Spain	40	10 N	0	14 W
<i>Mafstresby</i> , Spanish Provinces	50	34 N	0	23 E
<i>Magdeburg</i> , Saxony, Germany	51	45 N	0	50 E
<i>Majorca</i> , in the Mediterranean	39	0 N	0	10 E
<i>St. Maloes</i> , Bretagne, France	48	38 N	0	9 W
<i>Malaga</i> , Granada, Spain	36	0 N	0	16 W
<i>Malta</i> , near Sicily, Mediterranean	35	50 N	0	56 E
<i>Malacca</i> , East-Indies	2	8 N	6	42 E
<i>Mantua</i> , Italy	45	16 N	0	47 E
<i>Marseilles</i> , Provence, France	43	15 N	0	23 E
<i>Meca</i> , Arabia Felix	21	30 N	2	34 E
<i>Meeblin</i> or <i>Malines</i> , Spanish Provinces	50	50 N	0	9 E
<i>Medina</i> , Arabia Felix	24	15 N	2	22 E
<i>Menz</i> or <i>Muzenz</i> , Germany	49	44 N	0	33 E
<i>Messina</i> , Sicily	38	10 N	1	3 E

Muz,

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	Latit.		Dif. Me.	
	D.	M.	H.	M.
<i>Metz, Lorain, Germany</i>	48	50 N	0	24 E
<i>Mexico, North America</i>	10	0 N	6	56 W
<i>St. Michael, see Arch-Angel</i>				
<i>Milan, Italy</i>	45	28 N	0	38 E
<i>Minski, Lithuania, Poland</i>	54	6 N	1	53 E
<i>Minorca Island, Mediterranean</i>	39	10 N	0	16 E
<i>Mittau, Courland</i>	56	25 N	1	40 E
<i>Modena, Italy</i>	44	30 N	0	47 E
<i>Montpelier, Languedoc, France</i>	43	28 N	0	16 E
<i>Mons, Spanish Provinces</i>	50	20 N	0	15 E
<i>Mortlaix, Bretagne, France</i>	48	38 N	0	15 W
<i>Moscow, Capital, of Muscovy</i>	55	30 N	2	38 E
<i>Munster, Westphalia, Germany</i>	51	45 N	0	31 E
<i>Munchen, or Munich, Bavaria, Germany</i>	47	45 N	0	46 E
N.				
<i>Namur, Flanders</i>	50	10 N	0	23 E
<i>Nancy, Lorrain, France</i>	48	32 N	0	27 E
<i>Nantz, Bretagne, France</i>	47	12 N	0	6 E
<i>Nankin, or Nankuin, China</i>	31	0 N	7	54 E
<i>Naples, Italy</i>	41	45 N	0	59 E
<i>Narva, Livonia, Sweden</i>	58	55 N	2	2 E
<i>Narbonne, Languedoc, France</i>	42	50 N	0	12 E
<i>Nassau, Upper Rhine, Germany</i>	50	0 N	0	32 E
<i>Newmark, Transylvania</i>	47	30 N	1	26 E
<i>Nice or Nizza, Piedmont, Italy</i>	43	40 N	0	29 E
<i>Nismes, Languedoc, France</i>	43	30 N	0	18 E
<i>Nottsburg, Ingria, Sweden</i>	60	0 N	2	5 E
<i>Novograd, Weliki, Russia</i>	58	10 N	2	9 E
<i>Nuremberg, Franconia, Germany</i>	49	0 N	0	45 E
O				
<i>Olmutz, Bohemia, Germany</i>	49	32 N	1	10 E
<i>St. Omers, Flanders</i>	50	50 N	0	9 E
<i>Orange, Provence, France</i>	44	10 N	0	19 E
<i>Oran, Barbary, Africa</i>	35	33 N	0	0 E
<i>Orescrift, see Notteburg</i>				
<i>Orleans, Orleansois, France</i>	47	45 N	0	7 E
<i>Orvieto, Papacy, Italy</i>	42	27 N	0	53 E
<i>Otranto, Naples, Italy</i>	40	52 N	1	15 E
<i>Oudenard, Flanders</i>	50	46 N	0	13 E
<i>Oviedo, Austria, Spain</i>	43	10 N	0	23 W
P.				
<i>Padua, Italy</i>	35	32 N	0	50 E
<i>Palermo, Sicily</i>	37	26 N	2	30 E
<i>Panama, America</i>	1	10 S	5	30 W
<i>Paris, France</i>	48	45 N	0	9 E
<i>Parma, Italy</i>	44	42 N	0	44 E
<i>Pavia, Italy</i>	45	12 N	0	38 E
				<i>Pekin,</i>

Pole, and Difference of Meridians. 123

	Latit.		Dif. Me.	
	D.	M.	H.	M.
<i>Pekin, China</i>	39	52 N	7	23 E
<i>Pergamos, Natolia, Asia</i>	37	50 N	1	57 E
<i>Petersburg, Russia</i>	59	25 N	1	59 E
<i>Philadelphia, Natolia, Asia</i>	38	35 N	1	58 E
<i>Pisa, Tuscany, Italy</i>	43	55 N	0	45 E
<i>Placentia, Parma, Italy</i>	44	50 N	0	41 E
<i>Pleskow, Russia</i>	58	10 N	2	16 E
<i>Plowzko, Poland</i>	52	35 N	1	22 E
<i>Poitiers, Orleansois, France</i>	46	30 N	0	1 E
<i>Porto or Oporto, Portugal</i>	40	52 N	0	31 W
<i>Port Royal, Jamaica</i>	17	40 N	5	4 W
<i>Prague, Bohemia, Germany</i>	50	0 N	0	58 E
Q				
<i>Quebeck, Canada</i>	47	10 N	4	41 W
<i>St. Quintin, Picardy, France</i>	49	50 N	0	12 E
R.				
<i>Ratisbon, Bavaria, Germany</i>	48	34 N	0	49 E
<i>Ravenna, Italy</i>	44	25 N	0	51 E
<i>Rennes, Bretagne, France</i>	48	12 N	0	6 E
<i>Reims, Champagne, France</i>	49	20 N	0	16 E
<i>Rhodes Island, Archipelago</i>	35	30 N	1	57 E
<i>Riga, Livonia</i>	57	0 N	1	39 E
<i>Rosbel, Orleansois, France</i>	45	55 N	0	3 E
<i>ROME, Italy</i>	42	8 N	0	52 E
<i>Rotterdam, Holland</i>	51	50 N	0	17 E
<i>Roven or Roan, Normandy, France</i>	49	15 N	0	5 E
S				
<i>Saltsburgh, Bavaria, Germany</i>	47	20 N	0	54 E
<i>Salamanca, Leon, Spain</i>	40	45 N	0	19 E
<i>Salonicbi, Thessalonica, Turkey</i>	40	42 N	1	31 W
<i>Salerno, Naples, Italy</i>	41	8 N	1	3 W
<i>Sallee, Africa</i>	22	25 N	0	31 E
<i>Samarcand, Tartary</i>	40	0 N	4	15 E
<i>Santillana, Austria, Spain</i>	43	10 N	0	14 E
<i>Saragosa, Arragon, Spain</i>	41	20 N	0	3 E
<i>Sardis, Natolia, Asia</i>	38	10 N	1	56 E
<i>Savona, Genoa, Italy</i>	44	25 N	0	36 E
<i>Scanderoon, see Alexandretta</i>	37	10 N	2	31 E
<i>Schaffhausen, Switzerland, Germany</i>	47	28 N	0	35 E
<i>Segovia, Old Castile, Spain</i>	40	36 N	0	15 E
<i>Sens, Champagne, France</i>	48	0 N	0	13 E
<i>Setines, see Athens</i>				
<i>Seville, Andalusia, Spain</i>	37	0 N	0	20 W
<i>Siam, East-Indies</i>	14	5 N	6	43 E
<i>Sleswick, Denmark</i>	55	57 N	0	39 E
<i>Smolensko, Muscovy</i>	54	55 N	2	14 E
<i>Smyrna, Natolia, Asia</i>	38	4 N	1	36 E
Soissons,				

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	Latit.		Dif. Me.	
	D.	M.	H.	M.
<i>Soissons, France</i>	49	20 N	0	14 E
<i>Sophia, Bulgaria, Turkey</i>	42	32 N	1	30 E
<i>Spalato, Dalmatia, Turkey</i>	43	20 N	1	2 E
<i>Spires, Upper Rhine, Germany</i>	49	0 N	0	33 E
<i>Spoletto, Italy</i>	42	28 N	0	55 E
<i>Stockholm, Sweden</i>	59	30 N	1	16 E
<i>Strasburg, Upper Rhine, Germany</i>	48	17 N	0	31 E
<i>Sultzback, Bavaria, Germany</i>	49	10 N	0	47 E
<i>Surat, India</i>	21	30 N	4	47 E
<i>Syracuse, Sicily</i>	35	15 N	1	0 E
T.				
<i>Tangier, Barbary, Africa</i>	35	45 N	0	24 W
<i>Taranto, Naples, Italy</i>	40	40 N	1	11 E
<i>Tarragon, Catalonia, Spain</i>	40	55 N	0	5 E
<i>Temeswar, Hungary</i>	45	30 N	1	15 E
<i>Tetuan, Fez, Africa</i>	35	30 N	0	22 E
<i>Thebes, see Stives</i>				
<i>Tholouf, or Tolouse, Languedoc, France</i>	43	15 N	0	7 E
<i>Thorn, Poland</i>	53	0 N	1	18 E
<i>Tbyatira, Natolia, Asia</i>	38	28 N	1	54 E
<i>Tokay, Hungary</i>	48	12 N	1	15 E
<i>Toledo, New Castile, Spain</i>	39	30 N	0	14 W
<i>Tortosa, Catalonia, Spain</i>	40	34 N	0	2 E
<i>Torneo, or Torno, Lapland</i>	65	50 N	1	34 E
<i>Tours, Oileanois, France</i>	47	10 N	0	4 E
<i>Toulon, Provence, France</i>	43	0 N	0	25 E
<i>Tournay, Flanders</i>	50	35 N	0	14 E
<i>Trent, Austria, Germany</i>	45	50 N	0	46 E
<i>Treves, or Triers, Lower Rhine, Germany</i>	49	30 N	0	27 E
<i>Tripoli, Barbary, Africa</i>	33	5 N	0	55 E
<i>Tunis, Barbary, Africa</i>	35	30 N	0	51 E
<i>Turin, Piedmont, Italy</i>	44	50 N	0	31 E
V.				
<i>Valencia, Valencia, Spain</i>	39	15 N	0	1 E
<i>Valladolid, Old Castile, Spain</i>	41	28 N	0	15 W
<i>Vendosme, Orleansois, France</i>	47	45 N	0	4 E
<i>Venloe, Gelderland</i>	51	10 N	0	25 E
<i>Venice, Italy</i>	45	36 N	0	51 E
<i>Verdun, Lorrain, Germany</i>	49	10 N	0	21 E
<i>Verona, Venice, Italy</i>	45	25 N	0	48 E
<i>Vienna, Austria, Germany</i>	48	12 N	1	7 E
<i>Vienna, Dauphine, France</i>	45	26 N	2	43 E
<i>Ulm, Suabia, Germany</i>	47	55 N	0	41 E
<i>Upsal, Sweden</i>	59	55 N	0	14 E
<i>Utrecht, Holland</i>	52	0 N	0	20 E
W.				
<i>Warsaw, Poland</i>	52	10 N	1	28 E

Waterford,

	Latit.		Dif. Me.
	D. M.	H. M.	
Waterford, Ireland	53 0 N	0 29 W	
Wejel, Weitphalia, Germany	51 32 N	0 26 E	
Wiberg, Jutland, Denmark	56 25 N	0 37 E	
Wittenbergh, Saxony, Germany	51 28 N	0 53 E	
Wolfenbustel, Brunſwick, Germany	51 50 N	0 43 E	
Wormes, Germany	49 12 N	0 34 E	
Wurtsburg, or Wirtsburg, Franconia, Germany	49 20 N	0 41 E	
Y.			
Yvica, Mediterranean	38 40 N	0 5 E	
Z.			
Zell, Lunenburgh, Germany	52 30 N	0 42 E	
Zulnock, Hungary	47 58 N	1 13 E	
Zurick, Switzerland, Germany	47 15 N	0 33 E	
Zutphen, Gelderland, Holland	52 4 N	0 24 E	

CHAP. XXV. Concerning the Motion of the Hands of a Clock or Watch, as it re- presents the Motion of the Sun and Moon.

FOR a Conclusion of this Work, I shall here shew my Reader how naturally the *two* Hands of a *Clock or Watch* represent the Motions of the *Sun* and *Moon*: For as there are *twelve* Calendar Months, and *twelve* Signs in the Zodiack, so also are there *twelve* Hours upon the Dial Plate of a *Clock* and *Watch*. But as the *Moon* makes *thirteen* Conjunctions with the *Sun* in *one* Year, that is, in the Time the *Sun* apparently moves once round the Heavens, so the *Minute-Hand* of a *Clock* or *Watch* makes but *eleven* Conjunctions with the *Hour-Hand* in the Time it moves *once* round. For let the *Hour-Hand* represent the *Sun*, and the *Minute-Hand* the *Moon*, at *12 a-clock* they are *always* together, then they both moving forward, when the *Minute-Hand* comes again to *12*, it doth not find the *Hour-Hand* there,
but

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but is moved *one eleventh* Part of the whole Revolution further; therefore the *Minute-hand* must go 5 Min. 27 Sec. 16 Thirds, 21 Fourths, 49 Fifths $\frac{1}{11}$, before it make the *next Conjunction* with the *Hour-hand*. And

Just so it is with the *Sun* and *Moon*; for supposing the *new Moon*; to be upon the 21st Day of *March* in the very beginning of *Aries*, they both moving forward according to the order of the Signs.

When the *Moon* comes again to the very beginning of *Aries*, she doth not find the *Sun* there, he is moved 26 Deg. 55 Min. 46 Sec. more to the *East* in the *Ecliptick*,* so that the next Conjunction of the *Sun* and *Moon* will be made in *Aries* 29 Deg. 6 Min. 25 Sec. 12 Thirds, according to their *middle Motions*; and the next or *second new Moon* would be made in *Taurus* 28 Deg. 12 Min. 50 Sec. 24 Thirds; the *Third* in *Gemini* 27 Deg. 19 Min. 15 Sec. 36 Thirds; the *Fourth* in *Cancer* 26 Deg. 25 Min. 40 Sec. 48 Thirds, &c. every *new Moon* exceeding the Place of the foregoing by 29 Deg. 6 Min. 25 Sec. 12 Thirds, but they do not move equally as both the Hands of a *Clock* or *Watch*. Therefore the above *equal Law* of the *Sun* and *Moon* is not exactly observed; however, this may serve well enough to give an *Idea* of the *new Moons*, how it is nothing else but the passing of the *Moon* by the *Sun*, as the *Minute-hand* of a *Watch* doth by the *Hour-hand*, as represented by the following Table.

* See my *Uranoscopia* page 166.

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A New and Correct Table, shewing the exact Time that the Hands of a Clock or Watch meet through one Revolution, or the whole 12 Hours upon the Dial Plate of a Clock, &c.

N ^o .	Hours	H	I	II	III	iv	v
1	1	1	5	27	16	21	49 $\frac{1}{11}$
2	2	2	10	54	32	43	38 $\frac{2}{11}$
3	3	3	16	21	49	5	27 $\frac{3}{11}$
4	4	4	21	49	5	27	16 $\frac{4}{11}$
5	5	5	27	16	21	49	5 $\frac{5}{11}$
6	6	6	32	43	38	10	54 $\frac{6}{11}$
7	7	7	38	10	54	32	43 $\frac{7}{11}$
8	8	8	43	38	10	54	32 $\frac{8}{11}$
9	9	9	49	5	27	16	21 $\frac{9}{11}$
10	10	10	54	32	43	38	10 $\frac{10}{11}$
11	12	12	00	00	00	00	00

E X P L A N A T I O N.

The first Column to the *left Hand* shews the Number of *Conjunctions* of the *Hour* and *Minute-hand*, the *second* contains the *Hours*, the *third* the exact Times of their *meeting*.

As for Example.

The *two Hands* are *together* at 12 a-clock, and the *next Time* they will be *together* will be at 5 M. 27 Sec. 16 Thirds, 21 Fourths, 49 Fifths $\frac{1}{11}$ past one, the *third Meeting* will be at 10 M. 54 S. &c. past 2, the *fourth* at 16 M. 21 S. &c. past 3 a-clock, &c. as in the Table, and this is plain enough without any more Examples.

C H A P.

CHAP. XXVI. Of PAINTING Sun Dials,
*and first of the Planes or Surfaces on which
 DIALS are to be drawn.*

DIAL Planes are of *two* Sorts; *first*, such as are made on the Wall of a Building; or *secondly*, such as are drawn on Tables of Wood, vulgarly called *Dial-Boards*.

The *first* Sort, if they are made on *Brick-Work*, is done by plaistering on the Wall with Lime, Sand and Hair, mixed; this must be well drenched with *Linseed Oil*, after it is dry, *i.e.* as long as it will drink any; and then painted with Oil and White-Lead, that it may be durable.

But a better way is to temper the Lime, Sand and Hair with Ox Blood, which will be no great Charge, but of great Advantage; for this Mixture will equal in Time the hardness of a Free-Stone, and keep the Surface as free from the Injuries of Weather; but you must afterwards paint it white. The following Method is still preferable.

To make an exceeding strong Cement or Plaister, with which to form any Dial Plane upon the Side of a House or Wall, which will endure the Weather, not inferior to Stone.

Take *Lime* and *Sand*, and temper it with *Linseed Oil* to the Consistency of *Mortar*; or common Plaister, and spread it upon the Wall to a *competent* Thickness, and it will become as hard as a Stone, and last many Ages; and upon this you may describe a Dial, and put on the Lines, Figures and Furniture, as hereafter is directed.

Note,

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Note, If you are in the Country, remote from any Opportunity of getting *Linseed Oil*, you may make it with *skimmed Milk*, which will be much superior to Plaister made with Lime, Hair and Water.

If you are to draw a Dial upon a *Stone*, the best Way is to *drench* the Stone with *Linseed Oil* and *White-Lead* mixed *very thin*, till it will drink in no more; then shall the *Dial* you paint upon it, last longer, and be the better prepared against the Ruins of Time.

Now for *Tables* or *Dial Boards* of *Wood*, they being the most common, I shall give such Directions for making them, as have been always found most profitable and fit for the Purpose.

The best Woods for this Purpose, are the *clearest Wainscot*, and *yellow Fir*, provided it is clear of dead Turpentine Knots; there is not much Difference between these two Woods, as to their Alteration by the Weather, they being both subject to split in case they are bound, and have not free Liberty to shrink with dry Weather, and swell with Wet, though as to their lasting, Oak seems preferable; though good *yellow Fir* will last the Age of an ordinary Man, if well secured, as Things of this Nature ought to be.

In working either of these Kinds of Woods, the Boards ought first to be cut to such a Length as you intend your *Dial Board* should be, and so many of them as may make up the Breadth designed, and let them be joined on the Edges, and plained on both Sides, and afterwards set to dry.

For it has been observed, that though Boards have lain in a House ever so long, and are ever so dry, yet when they are thus shot and plained, they will shrink afterwards beyond Belief, if kept dry.

K

When

When you think they are dry enough, and will shrink no more, let them be shot again with good Joints, and let every Joint be secured with wooden *Dove-Tails*, let in a-cross the Joint in the *Backside*; let this be done after the Boards are glued together and well dried: after it has been thus glued, and the Joints are sufficiently dry, then let the *Face* of the Board be well plained and tried every Way that it may be both *smooth* and *true*, and the Edges shot true and all of a Thickness, as Pannels of Wainscot are commonly wrought.

The *Edges* must be true and even, that they may fit into the *Rabit* of a Moulding, put round it, just as a Pannel of Wainscot does in its Frame.

This Method will give Liberty to the Board to shrink without tearing; whereas Mouldings that are nailed round the Edges, as the common Way is, do so restrain the Motion of the Wood, that it cannot shrink without tearing; but Boards made this Way will last a long Time, without either parting in the Joints or splitting in the Wood.

Dials are some Times drawn on Planes lined with *Copper* or *Lead*, that they may be free from splitting or tearing; but a Board (*if it be made as before directed*) is to be preferred in many Respects. As *first*, In that it is much cheaper. *Secondly*, Both *Lead* and *Copper* will swell a little with the Heat of the Sun, and in Time will grow *hollow outwards*, or become *convex* instead of a perfect *Flat*, which will much pervert the Truth of its Shadow. And, *thirdly*, The Colours will be apt to peel from the Metal, and the Dial will by that means be in danger to be sooner defaced, than if it were painted upon a wooden Plane.

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To make the best Glue for gluing the Joints of Boards for Dials.

Take a *Quart of Milk* (but some have preferred Water) that has stood so long and been skimmed so often that no more Cream will arise; and when skimmed very clean boil it a little in a *leaden Pot*, and if any skum yet arise be sure to take it clean off; then put into the Milk about *half a Pound* of good Glue cut in small Bits, which will soon melt; boil it gently on a soft Fire to a *good Body*, but not to be too thick nor too thin; then take it off the Fire and keep it for Use. *Note*, Care must be taken in the Boiling that it do not *burn to the Sides of the Pot*, for that takes away much of the Strength of the Glue; but if it be made with due Care, it binds beyond any other Glue, and it is better able to resist the Weather, and therefore the fittest for gluing Boards for Sun Dials.

Care must be taken that your Glue be not made *too thin*, for if it be, the Wood will *so drink it up* that it will not be of a *sufficient Body* to bind the Parts together; on the contrary, if it be *too thick*, it will not give Way for the Joint to *shut close enough* to be strongly joined; for though it is Glue that makes the Joints stick, yet where there is so much of it that the Joint cannot close exactly, it will never hold firmly.

Whenever you use your Glue take care that it be *thoroughly hot*, for Glue that is not hot never takes firm hold on the Wood.

You must also take great Care that the Boards you are to glue have not been touched with *Oil* or *Grease*; for in such Places the Glue will never take hold, although after a Thing is once glued fast, no Grease nor Oil can hurt it.

The Glue being ready, and the Joints of the Board shot true, set *both* the Faces of the Joint close together, and both also *turned upward*; then dip a Brush in the Glue and besmear the Faces of both Joints *as quick as possible*, then clap the two Faces of the Joint together, and *slide or rub them long ways* one upon another two or three Times to settle them close, and so let them stand till they are firm and dry.

To prepare your Oil for laying on the Colours upon Dials.

Take One Gallon of *Linseed Oil* and set it upon a *Charcoal Fire*, and when it is about to boil put into it *two Pounds of Red Lead*, and let it boil together for *about an Hour*; but the best Way to know when it is boiled enough, is to take a little of it out and let it cool, and then if it *ropes like thin Tar*, it is enough: This done, put a *lighted Paper* to it, and set it on Fire to consume the greasy Part of it, which will be done in a Minute or two, more or less, according to the Quantity of your Oil; and when it has burnt *long enough* clap a Cloth or any other Thing close over it, and extinguish the Fire; after which let it *cool and settle*, then decant the *clear Oil* from the Dregs, and keep it in a *Bladder* for Use.

This is called *drying Oil*, and with this the several Colours are to be ground in order to paint, so as to *endure the Weather*; but you must observe that your Colours are *thoroughly dry* before they are *exposed*. The several Colours I shall describe hereafter.

N. B. The *above Method* of making the *drying Oil* has one Inconvenience in it, that it makes the Oil of a *deep reddish Colour*, which in some Cases may alter the *Nature and Beauty* of some Colours, as *Whites*, which are liable to become *Yellow*; also

Blues

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Blues may by this Means become *greenish*; to prevent which, *in the preparing of your Oil*, instead of *Red Lead* use *Letharge of Gold*.

Of Colours used in Painting Sun-Dials.

The Colours generally used in Painting Sun Dials are:

For *White*, Ceruse and White Lead.

For *Black*, Lamp-Black, Ivory-Black, Charcoal, and Sea-Coal Black.

For *Red*, Red Lead, Vermillion and Cinnabar Lak.

For *Green*, Verdigrease.

For *Blue*, Indigo, blue Bice, blue Verditer and Smalt.

For *Yellow*, yellow Oker, and yellow Pink.

For *Brown*, Spanish Brown.

With the above Colours you may compound Variety of other Colours, viz.

An *Ash Colour* is made by mixing a little Lamp-Black with White.

A *Purple* is made by mixing Cinnabar Lak and blue Bice.

A *Carnation* is made by mixing Cinnabar Lak and White.

A *Green* is made by mixing blue Bice with yellow Pink. N. B. Any Blue and Yellow make a *Green* of some Degree or other.

A *Light Blue* is made by mixing blue Bice and White.

A *Lead Colour* is made by mixing Indigo with White.

A lively *Grass Green* is made by mixing Verdigrease with yellow Pink.

And by this Means may several other Colours be compounded and made *lighter* or *darker* at Pleasure, as a little Practice will make evident.

To prepare the Colours for Painting Sun-Dials.

Before you proceed to the painting of Sun Dials in their several Colours, it is first necessary that they be *primed*, that is, painted *two or three* Times over with Oil, and Colour prepared for that Purpose, to fill up the Cavities which may (after plaining) remain in the Wood, and to make it perfectly plain, and the more capable to receive and retain other Colours; and of all Priming *Spanish Brown* is reckoned to be the chief; for, not to mention its Cheapness, it *dries kindly*, and gives the Oil a sufficient Time to penetrate into the Wood: and consequently both resists the Weather, and also freely receives all other Colours which are laid upon it: it is of itself of a *Horse-flesh Colour*, and (besides its Usefulness in priming) is a *natural Shadow* for *Vermilion*, and may be made lighter or darker, according to the greater or less Quantity of *White* mixed with it; though in priming, it requires not any Mixture, but only the Oil itself.

In preparing the *Spanish Brown* for priming, grind it very well with the afore-mentioned *drying Oil*, and make it for the *first Priming* somewhat *thinner* than you would do it for painting, that it may more easily penetrate into the Wood; which being dry, do it over a *second Time* with the same Mixture, only mix it a *little thicker*; and letting that dry, do it a *third Time*, mixing your Colour *thicker* every Time; and take Care in the Priming, not only to rub the Brush with the Priming all over the Plane, both on the *Back*, as well as on the *Fore-side* and *Edges*, the better to preserve it, but also to *bob* it against it, that the Priming may be sure to pierce into all the Cavities or Pores of the Wood:

Wood: when this last Time of colouring with your Priming is dry, then colour the *Face* of the Plane over with *white Lead*, and when it is dry do it over again *three* or *four Times* more successively, after each drying; and so will the *Face* of your Plane be of a beautiful white Colour, and it will also be sufficiently defended against the Fury and Violence of the *Weather* for many Years; when the last colouring of your white is dry, your Plane is ready for laying on the Colours, viz. painting the *Hour Lines*, or what *Ornament* or *Furniture* you think fit to have upon it.

OBSERVE as a general Rule, that priming is to be mixed or tempered *thin*, but Colours for Lines or Figures to endure the Weather, must be tempered *thicker*, the better to resist the Fury of stormy or moist Weather.

If you are only for making a common Sun Dial, these four Sorts of Colours will be sufficient.

1. *Spanish Brown*; which prepare, and therewith prime your Dial, as before directed.

2. *White Lead*, well ground in Oil; with which, after the Priming is *thoroughly dry*, go over it three or four Times, letting it dry between every Time; which not only makes a beautiful white Ground, but fortifies it yet more against the Fury of the Weather.

3. *Lamp-Black*, for drawing the *Hour Lines* and *Figures*.

4. *Vermilion*, for drawing the *Parallels of Declination*, or what other *Furniture* you think fit to put upon it.

The *Spanish Brown*, *Lamp-Black* and *Vermilion*, are all to be ground in the *drying Oil*, described in Page 132; and for the *White Lead*, it is to be used in the same Manner; only in making *drying Oil*

To prepare the Colours for Painting Sun-Dials.

Before you proceed to the painting of Sun Dials in their several Colours, it is first necessary that they be *primed*, that is, painted *two or three* Times over with Oil, and Colour prepared for that Purpose, to fill up the Cavities which may (after plaining) remain in the Wood, and to make it perfectly plain, and the more capable to receive and retain other Colours; and of all Priming *Spanish Brown* is reckoned to be the chief; for, not to mention its Cheapness, it *dries kindly*, and gives the Oil a sufficient Time to penetrate into the Wood: and consequently both resists the Weather, and also freely receives all other Colours which are laid upon it: it is of itself of a *Horse-flesh Colour*, and (besides its Usefulness in priming) is a *natural Shadow* for *Vermilion*, and may be made lighter or darker, according to the greater or less Quantity of *White* mixed with it; though in priming, it requires not any Mixture, but only the Oil itself.

In preparing the *Spanish Brown* for priming, grind it very well with the afore-mentioned *drying Oil*, and make it for the *first Priming* somewhat *thinner* than you would do it for painting, that it may more easily penetrate into the Wood; which being dry, do it over a *second Time* with the same Mixture, only mix it a *little thicker*; and letting that dry, do it a *third Time*, mixing your Colour *thicker* every Time; and take Care in the Priming, not only to rub the Brush with the Priming all over the Plane, both on the *Back*, as well as on the *Fore-side* and *Edges*, the better to preserve it, but also to *bob* it against it, that the Priming may be sure to pierce into all the Cavities or Pores of the Wood:

Wood: when this last Time of colouring with your Priming is dry, then colour the *Face* of the Plane over with *white Lead*, and when it is dry do it over again *three* or *four Times* more successively, after each drying; and so will the *Face* of your Plane be of a beautiful white Colour, and it will also be sufficiently defended against the Fury and Violence of the *Weather* for many Years; when the last colouring of your white is dry, your Plane is ready for laying on the Colours, *viz.* painting the *Hour Lines*, or what *Ornament* or *Furniture* you think fit to have upon it.

OBSERVE as a general Rule, that priming is to be mixed or tempered *thin*, but Colours for Lines or Figures to endure the Weather, must be tempered *thicker*, the better to resist the Fury of stormy or moist Weather.

If you are only for making a common Sun Dial, these four Sorts of Colours will be sufficient.

1. *Spanish Brown*; which prepare, and therewith prime your Dial, as before directed.

2. *White Lead*, well ground in Oil; with which, after the Priming is *thoroughly dry*, go over it three or four Times, letting it dry between every Time; which not only makes a beautiful white Ground, but fortifies it yet more against the Fury of the Weather.

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4. *Vermilion*, for drawing the *Parallels of Declination*, or what other *Furniture* you think fit to put upon it.

The *Spanish Brown*, *Lamp-Black* and *Vermilion*, are all to be ground in the *drying Oil*, described in Page 132; and for the *White Lead*, it is to be used in the same Manner; only in making *drying Oil*

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for *White Lead*, instead of *Red Lead*, use *Litharge of Gold*, and proceed as before.

But if you would have your Dial more rich, you must first consider, what Colours you resolve to have your Lines, Figures, &c. to be, and upon what Ground your determined Colours will appear most beautiful. As,

1. *Gold* appears best upon a *Blue* Ground, and indifferently upon a *Red*.

2. *Blue* and *Green* appear best upon *Yellow* and *White*.

3. *Red* sets off with *Yellow*, *White*, *Blue*, or *Green*.

4. *Yellow* sets off with *Black*, *Blue*, and *Red*.

Besides the Directions given already for preparing and laying on common Colours, it will be necessary to speak of the laying on the more rich and beautiful Colours; and first of *Gold*.

To make Gold Size, with which you design to lay on Leaf Gold.

Take *yellow Oker*, and grind it with *Water* on a Stone with a Muller, till it be very fine, and then lay it to dry, and grind it with the afore-mentioned drying Oil, as you would grind other Colours, observing to put so much of each, that it may be of a competent Stiffness to work well, and of such a Body, that it may settle itself smooth when laid on, but not so thin as to run; and take care to grind it very fine, and it will add the greater Beauty to your Gold that is to be laid on with it.

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To lay Leaf-Gold on an Oily Size, or to make any Lines, Figures, &c. of Leaf Gold upon your Dial.

Draw your Lines, Figures, or Letters, or what you think fit to have in Gold, with *Gold Size*, (above-mentioned;) which dry so, that when you touch it with your Finger it will *stick a little* to it, but the Colour not *come off*; for if the Colour *comes off* on the Finger, then it is not dry enough, and must be let alone a little longer; for if you should then lay the Gold on, it would drown it so that it would be worth nothing; and on the other Hand if the Size should be so dry as to hold your Finger, as it were to it, then is it too dry, and the Gold will not take, for which there is no Remedy but new sizing: therefore you must watch that it be not too wet or too dry. Then cut your Leaf Gold as near as you can, into the Form you would have it, whether of Figures, Letters, Lines, &c. (taking care to cut it rather *too large* than *too little*;) and with a flat Stick lined with woollen Cloth, first rubbing it on your Cheek, or breathing on it, take up your Gold (so cut) and put it upon the Size, and the Gold will leave your lined Stick, and cleave to the Size; then *press it down* with *Cotton*, or *Hare's Foot*, and take care that you make the Figures, Lines, or Letters, in the *Gold Size*; and that you cut the Gold *large enough* to cover the Figures so made in the Size; and when it is *thoroughly dry*, brush off the loose Gold, and the painting will remain beautiful, and be able to endure the Weather.

Note further, That a Book of Gold contains 25 Leaves, each Leaf being three Inches square; the Price of each Book is Two Shillings at the Gold-Beater's; one Book will cover 225 square Inches of Work; for so many square Inches are contained in 25 Leaves, that are three Inches square, every Leaf containing nine square Inches superficial in Gold. The right understanding of this will much guide you in judging how many Books of Gold will serve to gild that Work, whose superficial Contents in square Inches may before-hand be known.

To lay on Smalt to make a fine Blue.

When you have laid on what you think fit in *Leaf Gold*, take *white Lead*, mix it *pretty stiff* with *drying Oil*, and with a *Pencil* lay that on where you intend your *Blue* shall be, and then put your *Smalt* in a *fine Searce*, and sift it on to the *Dial*, and with a *Piece of Cotton* dab it down upon the *White* before laid on, and when it is *thoroughly dry*, wipe off all the loose Colour with a *Feather*, and blow off the *Dust* with a *Pair of Bellows*, which will easily blow off all, except what fell upon the *White* before laid on to retain the *Blue*, which will be a very beautiful *Blue*.

Of the Nature and Colour of some of the principal Ingredients used in painting of Sun Dials.

1. *CERUSE* and *White Lead* are the only Colours to be used in painting in *Oil*, and besides their Usefulness in painting of *Dials*, Paint made up with them and *Oil*, is frequently made use of in painting *Posts*, *Palisadoes*, *Gates*, *Doors*, *Windows*, *Wainscoting*, &c. and answers the End of Painting, both as to *Beauty* and *Preservation*, for they dry well, and strongly resist the *Weather*; and if you would have them to dry yet more speedily, you may in the tempering put a little *Oil of Turpentine*, if it be with-
in *Doors*; but without *Doors*, it is better without, because that does not so well resist the *Weather*.

2. *Lamp-Black* is a good *Black*, if it be first burnt, then ground, and lastly tempered with *Oil*.

3. *Charcoal* is a *Black* that will serve for ordinary Uses; it dries well, but great Care must be taken that it be well ground.

4. *Spanish Brown*; the best is a deep bright Colour,

lour, and free from Stones, and being very well ground, is the best for priming: It is of a *Horse Flesh Colour*, and a *proper Shadow* for *Vermilion*.

5. *Red Lead* is a *great Drier* and *Binder*; for which Reason it is made use of in the *drying Oil*; it resists the Weather as well as any Colour whatsoever.

6. *Vermilion* is a rich Colour, and of a good Body, but Care must be taken that it be finely ground, even as *soft as Oil*, and then it will work extraordinary well: It is best to buy it *in the Stone*, lest you meet with some that has been *adulterated* with *Red Lead*, or the like; it is a perfect *Scarlet* of itself, and may be altered to several Varieties, by mixing with other Colours.

7. *Cinnabar Lak* is a *rich Crimson* Colour, and must be very fine ground.

8. *Smalt* is a very *fine Blue*, and it is best to be strewed on, as before taught; for if you work it in *Oil*, (though you wash it and mix it with *White Lead*) yet it will *turn black in Time*; if you buy it to work in *Oil*, the *finest* is best, which is called *Oil-Smalt*.

9. *Blue Bice* is a *pale Colour*, and works well, though a little sandy.

10. *Blue Verditer* is not so good a *Blue* as *Bice* and *Smalt*, though it may serve in *Dial-painting*, where they are wanting; but it is a little sandy, and apt to *fade* and *turn greenish*.

11. *Indigo* is a very *dark Blue*, and commonly lightened with *White*, when used in *Painting*, except in *Shadowing*; it grinds fine, and is very proper for the *last Colour* of *Posts*, *Palisadoes*, *Doors*, *Windows*, &c. for it resists the Weather, and preserves the Wood.

12. *Blue Balls* are almost like *Indigo*, but not so good a Colour, nor will it endure so long.

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13. *Umber* is a *Hair Colour*, it must be very finely ground, which to effect, requires a great deal of Labour; it *dries* and *binds* exceedingly, and is therefore also very proper for painting without Doors, as Doors, Pallisadoes; if calcined in a *Crucible*, it is a *natural Shadow* for *Gold*, and some other Colours.

14. *Verdigrease* is a perfect *willow Green*, but may be altered at Discretion, with *Yellow*, &c. but being very *foul*, it must be mended or cleansed, which may be thus done: Grind it fine, and put to it eight Times its Weight of Spirit of Vinegar, digest till the Vinegar is tinged very green, then decant the Colour; cast away the *Fæces*, and evaporate the Vinegar in a *Brass Vesica*, so have you a very good *Verdigrease* at the Bottom, much more fine and valuable, then before it was cleansed; it dries very speedily.

15. *Yellow Oker*, the *English*, the Colour of fresh *Wheat Straw*; the foreign is of somewhat a more deep Colour; it is much used in common Painting, being ground very fine.

16. *Yellow Pink* is a *greenish Yellow*; it grinds well, and is good to mix with other Colours, to make a *Green*.

Of these Colours some require washing, as *Red Lead*, *Blue Bice*, *Smalt*, and *Verditer*, which is thus performed:

Put the Colour into a glazed Vessel, and put thereto plenty of clear Water; wash it well, and (after a while) decant the Water; repeat this Work six or seven Times; at last (the Water being but just troubled) put it into another glazed Vessel, leaving the Dregs at the Bottom; then put some more Water into this second Vessel, and wash it as before, till the Water, after settling, be clear, and the Colour remain fine at the Bottom.

Note,

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Note, Before you take the Colour out of the Vessel, *spread it* about the Sides of the Vessel *very thin*; and when it is dry, it will Part of it fall down to the Bottom, which keep by itself; but that which sticks to the Sides of the Vessel is the best, and is as fine as any Flower; that strike off with a Feather, and keep it for Use.

The Colours that require *washing* being thus prepared, (or if they are those that do not require washing, they are done without) your next Work is to *grind them*, which is done thus:

Take a Spoonful or *two* of the Colour you intend to grind, and put to it a little *linseed Oil*, (but be careful you put in too little rather than too much;) mix them together, and upon your Stone with a Muller grind them well, adding Oil by *Degrees*, as you see it requires it, to make it like an Ointment, (always observing that it grinds much better when it is *thick*, than when it is *so thin* as to run about the Stone;) every now and then scrape it up together with a *thin Knife* or *Lanthorn-born*, to keep it at or near the Middle of the Stone, and so continue to work till you have ground as much as you have Occasion for; which done, clean your Stone by grinding *Sand* and *Water* upon it, and then wash and dry it, and the Muller; and when you go to make Use of it, mix it with *drying Oil*, till it be so thin as to *run freely* from the Pencil, yet so thick that the Ground may not *appear through* it, or to *run* when it is laid on, and then it will be the more beautiful Colour, and better endure the Weather.

CHAP.

Note, Dials are not to be refreshed but by new Painting; yet here take Notice, that I think it not convenient at all to lay new Colouring upon the old Ground of a *Sun Dial*, (that is, to draw the old Lines and Figures over again in the same Posture, wherein they were drawn

CHAP. XXVII. *The Manner of Painting Timber Work*

BY *Timber Work* I mean all Manner of Wain-scoot, Doors, Windows, Posts, Rails, Pails, Gates, Border-boards for Gardens, &c. to preserve them from the Violence of Rain or Injury of the Weather; the Method of doing which, I shall here lay down as plain as I can.

Suppose then that there be a Set of *Palisadoes*, or a *Pair of Gates*, or some *Posts* and *Rails* to paint, and I would finish them in a *Stone Colour*; first look over the Work, and take Notice whether the Joints be open in the Gates, or whether there be any large *Clefts* in the Posts; for if these are not secured, the *Wet* will insinuate itself into those Defects, and make the quicker Dispatch in rotting the whole Work: Let the first Business therefore be to stop up these

(drawn before) but rather to take the Declination a-new, and according thereunto make a new Draught of your Dial, and proceed in the painting of it, in all Respects, as if it were a new Dial; for it is observed, that Dials which were made many Years, as thirty or forty Years ago (which we believe went true when first made) will not give the true Hour now, but go very false, which is caused by some secret Motion of the Earth, not hitherto taken Notice of, which apparently alters the Declination of all *Planes* whatsoever. If any one requires more Satisfaction herein, let him repair to some old Dial that was made many Years ago, and according to the Distance of the Substile from the Meridian, let him find out the Declination when first made, as any Man that is an Artist can easily do; then let him take the Declination of the Plane by the Sun, and he shall find these two Declinations to differ considerably, according to the Number of Years contained between your Observation, and the Time of the Dial's first making: So that a Plane that stood full South thirty, forty, or sixty Years ago, shall now decline some Degrees either to the East or West, according to the Nature of the Earth's Motion, which is that which is called the *Precession of the Equinox*, which is found by Observation to differ much in the same Country, in the Space of fifty or sixty Years, as all skilled in *Astronomy* very well know.

Places

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Places smooth and even with *Putty*, which is made of Whiting and Linseed Oil, well beaten together on the grinding Stone, or with a wooden Mallet, to the Consistence of a very stiff Dough, and with this let all the Crannies, Clefts, and other Defects be perfectly filled up, that it may be *equal* to the Surface or Outside of the Stuff; then proceed to the priming of the Work with some *Spanish Brown* well ground and mixed very thin with Linseed Oil; with this do over the Work, giving it as much Oil as it will drink up; this in about *two* Days will be indifferently dry: then, if you would do the Work substantially, do it over again with the same priming Colour; when it is thoroughly dry, then take white Lead well ground and tempered up, but not *too thin*, for the *stiffer* you work it, if it be not too stiff, the better Body will be laid on; and the longer it will last: let the Colour be well rubbed on with a large Bristle Brush, and the whole Surface of the Work be so entirely covered, that there remain no Crack nor Corner bare, which you may easily do by *jobbing* in the Point of a Bristle Brush: Let this first Colouring dry, and then go over it a *second Time*, and if you please a *third* also: the Charge will be a little more, but the Advantage will be great in the Duration. This Course is sufficient for any Kind of *Timber Work* that requires only a plain Colour, whether you thus cover the Work with a *Stone Colour*, or else with a *Timber Colour* in *Umber* and *White*, or a *Lead Colour* with *Indigo* and *White*, that with *White* being cheapest of the three by much: nay I have known some lay over their Work only with a Coat of *Spanish Brown*, by tempering it up more stiff than was done for the two first Primings, which in some Respects is cheapest of all,

all, and preserves the Timber perhaps as well as any. Now he that is able to bring the Work thus far on, has proceeded to the highest Pitch of that vulgar Painting, that aims at Preservation beyond Beauty, though something of Beauty is necessarily included in this also; but this is not all, for he that is arrived thus far, is in a fair Way to other Perfections in the Art of Painting; but for the Painting of *Wainscot* with its proper Shadows, and for imitating *Olive* and *Walnut Wood*, *Marbles*, and such like, these must be attained to by ocular Inspection; it being impossible to deliver the Manner of the Operation by Precept without Example; and I am bold to affirm, that a Man shall gain more Knowledge by one Day's Experience, than by an Hundred spent to acquire it some other Way.

I advise therefore all those that desire an Insight into this Business, to be a little curious, if Opportunity offers, in observing the Manner of a Painter's working, not only in grinding his Colours, but also in laying them on, and working in them, in all these observing the Motion of his Hand, in the manage of any Kind of Tool, and by this Means, with a little imitation joined to the Directions here given, I doubt not but in a short Time you may arrive to great Proficiency in the Business of vulgar Painting.

Note, That if when you have made use of your Colours, there be Occasion for a small Cessation till the Work be finished, in this Case it is best to cover the Colours, if any remain in your Pots, with *Water*, for that will prevent their *drying*, even in the hottest Time.

And for your Pencils, they ought, so soon as you have done working, to be well washed out in clean *Linseed Oil*, and then in warm Soap-Suds; for if
either

Chap. XXVII. *Of Painting Timber Work.* 145
either Oil or Colours be once dried in the Brush or Pencil, it is spoiled for ever.

It has been observed, that Timber laid over with *White*, when it has stood some Time in the Weather, the Colour will *crack* and *shrink* up together, just as Pitch does, if laid on any Thing that stands in the Sun; the Cause of this is the Colour's being laid on with *too stiff a Body*, for being wrought *too thick* once, it will dry with a *Skin on the Outside*, which will keep the *Inside* moist and prevent its binding firm, from whence those Cracks proceed.

Take notice, that if you shall at any Time have occasion to use either Brushes that are very small, or Pencils, as in many Cases there will be occasion, you ought then to dispose of the Colours you use upon a *Pallet*, (which is a wooden Instrument easy to be had at any *Colour Shop*;) and there work and temper them about with your Pencil, that the Pencil may carry away the more Colour; for you are to note, that if a Pencil be only dipt into a Pot of Colour, it brings out no more with it than what hangs on the *Outside*, and that will work but a little Way, whereas if you rub the Pencil about in the Colour, on a Pallet, a good Quantity of Colour will be taken up in the *Body of the Pencil*; and besides all this, you may work your Pencils better to a Point on a Pallet, than you can do in a Pot; the Point of a Pencil being of greatest Use in divers Cases, especially in drawing of Lines, and all kind of Flourishing.

I shall still be more particular under this Head of Painting, because Painters Work is very expensive, and is the only Part in Building wherein a Gentleman can be assisting either by himself or Servants, it being almost impossible for any Gentleman to do either *Masons, Bricklayers, Carpenters, or Smith's Works,*
L. whereas

whereas it is now well known, that several Noblemen and Gentlemen have by themselves and Servants painted whole Houses, without the Assistance or Direction of a Painter, which when examined by the best Judges could not be distinguished from the Work of a professed Painter.

And that which conduces most to this Practice is the vast Disproportion between the Prices which Painters charge for their Work, and the Expence which Gentlemen are at in this Method of Painting, which at the utmost doth not amount to *one fourth* Part of the Painter's Price, to prove which I shall set down the Prices of Colours, and likewise shew what *Number of Yards* one Pound of each Colour will paint.

First Primer ground in Oil, at 36s. per 112lb. weight, or 4d. per lb. One Pound of which will paint 20 *square Yards*.

Second Primer ground in Oil, at 36s. per 112lb. weight, or 4d. per lb. One Pound of which will paint 12 *square Yards*.

Best White Lead ground in Oil, at 36s. per 112lb. or 4d. per lb. One Pound of which, with two pennyworth of Oil, will paint 8 *square Yards*, which is three Farthings per Yard; for which Painters usually charge 4d. per Yard.

1. *Pearl Colour* ground in Oil, at 4d. and 5d. per lb.
2. *Lead Colour* ground in Oil, at 4d. and 5d. per lb.
3. *Cream Colour* ground in Oil, at 4d. and 5d. per lb.
4. *Stone Colour* ground in Oil, at 4d. and 5d. per lb.
5. *Wainscot, or Oak Colour* ground in Oil, at 4d. and 5d. per lb.

N.B. One Pound of any of these five Colours, with Oil, will paint eight *square Yards*, for which Painters usually charge 4d. per Yard.

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1. *Chocolate Colour* ground in Oil, at 6d. per lb.
2. *Mahogany Colour* ground in Oil, at 6d. per lb.
3. *Cedar Colour* ground in Oil, at 6d. per lb.
4. *Walnut-tree Colour* ground in Oil, at 6d. per lb.

N.B. One Pound of any of these four Colours, with Oil, will paint 10 square Yards, for some of which Painters usually charge 4d. per Yard, for others more.

1. *Gold Colour* ground in Oil, at 8d. per lb.
2. *Olive Colour* ground in Oil from 8d. to 12d. per lb.
3. *Pea Colour* ground in Oil from 8d. to 12d. per lb.
4. *Fine Sky Blue* mixed with *Prussian Blue* ground in Oil from 8d. to 12d. per lb.
5. *Orange Colour* ground in Oil, at 12d. per lb.
6. *Lemon Colour* ground in Oil, at 12d. per lb.
7. *Straw Colour* ground in Oil, at 12d. per lb.
8. *Pink Colour* ground in Oil, at 12d. per lb.
9. *Blossom Colour* ground in Oil at, 12d. per lb.

N. B. One Pound of any of these nine Colours, with Oil, will paint eight square Yards, for some of which Painters usually charge 10d. or 12d. per Yard, for others they will expect more.

Fine deep Green ground in Oil, at 2s. 6d. per lb.

N. B. One Pound of which, with Oil, will paint 20 square Yards, for which Painters usually charge 12d. per Yard.

Oils used in House-painting are,

1. *Linseed Oil*, at 1d. per Quart.
2. *Turpentine Oil*, at 12d. per Quart.
3. *Best drying Oil*, at 12d. per Quart.

Painting

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Painting Brushes of several Sizes from 2d. to 6d. each.

Putty at 4d. per lb.

Double Size used by the Painters for priming new Work at 4s. per Firkin, or 2d. per Quart.

Single Size at 18d. per Firkin, or 1d. per Quart.

These Colours, with all other Materials used in Painting, are prepared in the best Manner, and sold by ANDERTON POOLE, Oil and Colourman, the Corner of *Mark-Lane, Tower-Street*, LONDON. He likewise gives printed Directions for the using of his Colours, or procures Painters to work for Gentlemen by the Day, if required.

F I N I S.

